POWER

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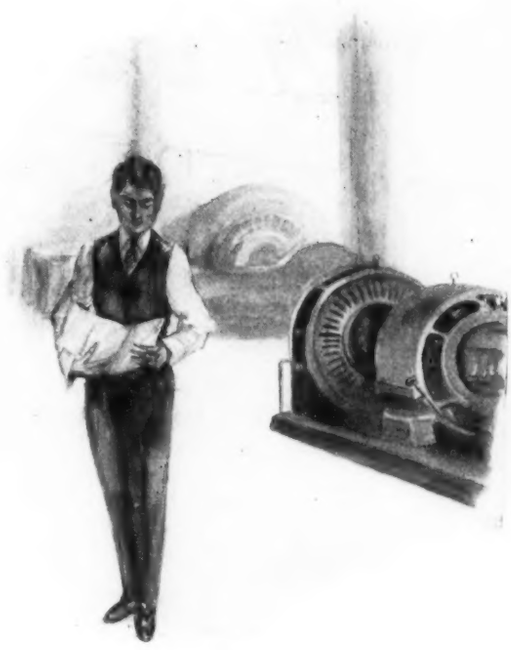
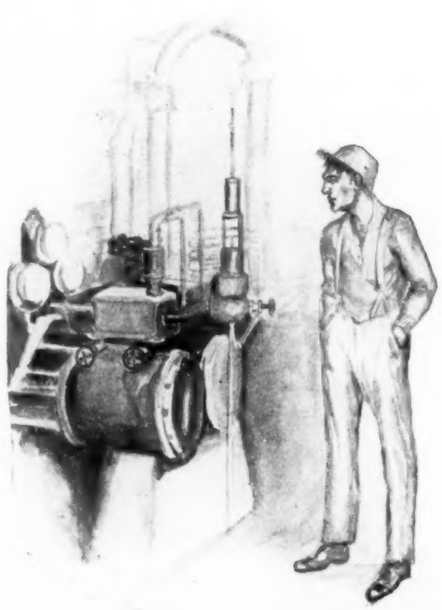
The Other Fellow's Job

By R. T. Strohm

ON conversation a la mode an' grammar rules I'm shy,
I ain't exackly what you'd call an educated guy;
For all the learnin' I annexed I sorter picked by hand,
An' so there's hobs an' gobs of things that I can't understand.
I never muddle up my brain or worry very much
With scientific arguments, sikeology an' such,
But here's a point on which I wish you'd set my mind at rest—
Why is the other fellow's job the one that seems the best?



The other fellow's plant is sure one cool an' quiet spot,
While Hades ain't got much on mine for bein' dry an' hot,
But I keep pluggin' on in hope that some day, in a clinch,
I'll get the hammerlock on Luck an' land me such a cinch.
There ain't no pipe around my joint to give me dippy dreams—
But notwithstandin' that's a fact, to me it kinder seems
The other fellow's got the corn an' I have got the cob,
When I size up the work I do with what he calls his job.



I'M wise the other fellow has his little troubles, too,
But they can't hold a candle to the ones that I go through;
Besides, that guy goes smoochin' round with loads of time to burn
While I'm so, tarnal busy that I don't know where to turn.
I ain't invitin' sympathy—you get me there, I hope—
I'm just a-tellin' you the way I figger out the dope;
An' so I can't help envyin' the other lucky chap,
Because it allus looks to me he has a bloomin' snap.

He don't go rollin' round the town inside a limousine,
Nor even own a flivver for combustin' gasoline;
He 'tends the movies now an' then, with kiddies an' the wife,
An' in a modest style he seems to be enjoyin' life.
He's just an ordinary dub, as far as I can see,
Who hustles for his daily bread an' pie the same as me;
Yet I'd be mighty thankful if I only could be shown
Just why that other fellow's job looks better than my own.

Endurance-Efficiency Pump Tests

By L. A. Quayle*

SYNOPSIS—Data pertaining to endurance and efficiency tests on four motor-driven, centrifugal, high-pressure, fire-service pumps. The method used to correct the over-registration of the discharge venturi meter is also given.

Before Cleveland's high-pressure fire-service station, which was built by the Water Department, was turned over to the Fire Department for operation, a 16-hour endurance run was made with all the pumps working at full capacity; efficiency tests of each pump were also run, to determine whether they would meet the specified capacity and efficiency guarantees made by the builder.

The pumps have a rated capacity of 2800 gal. per min. against a discharge pressure of 270 lb. with a suction pressure of 30 lb. Four units have been installed and provisions made for two more. Current is supplied to the station through duplicate 11,000-volt cables from the municipal substation in the rear of the fire-service building, and it is transformed in the station to 460 volts. The department pays three cents per kilowatt-hour for current consumed, and 6 per cent. interest on a municipal-light cable costing approximately $20,000.

Each unit is equipped with an independent panel upon which the direct-current starting contactors are mounted, also the pump-suction and discharge-pressure gages. The control switches for starting and stopping the main units and opening and closing the 14 motor-operated valves are mounted on the main switchboard; see photograph.

TABLE I. PUMP AND MOTOR DATA

Motors:	
Rated brake horsepower at full load	550
Synchronous speed, r.p.m	1,200
Pumps:	
Type	Allis-Chalmers—Centrifugal
Number of stages	5

The discharge pressure maintained by each pump is controlled by a pressure-regulating valve which bypasses varying quantities of water from the pump-discharge nozzle back to the suction nozzle, depending on the pressure to be maintained.

TABLE II. RESULTS OF ENDURANCE TEST

General Data:	
Duration of test, hours	16
Number of pumps operated	4
Pump Speed and Gallons Pumped:	
Average speed during test, r.p.m	1,193
Average quantity of water discharged, based on manometer of suction venturi, gal. per min	11,706
Average rate of pumpage for 24 hr., mill.gal	16.86
Average Pressures:	
Average discharge pressure at pumps, lb	274.1
Average discharge head at pumps, ft	633.2
Average suction pressure at pumps, lb	33.1
Average suction head at pumps, ft	76.5
Increase of pressure due to pumps, lb	241.0
Increase of head due to pumps, ft	556.7
Economic Results:	
Average water horsepower developed by the pumps, based on the suction venturi meter	1,647
Average station efficiency based on suction venturi meter, per cent	64.1

Principal data on the pumps and motors are given in Table I. The results of the endurance test with all pumps operating are given in Table II. This test was stopped after a run of 16 hours because all the equipment operated satisfactorily from the moment it was started and the cost of current was approximately $59 per hour. We believe the over-all station efficiency of 64.1 per cent., which includes transformer losses, obtained on this run is good, since reliability is of more importance than efficiency in a station that operates less than one hundred hours per year. The results of the efficiency tests are given in Table III. All readings were taken on instruments calibrated by the Electric Testing Laboratories, New York. An efficiency of 72 per cent. was guaranteed on the pumps and 94 per cent. on the motors. They all bettered the guarantee by a reasonable margin. These pumps have been in operation over three years, and since they have never failed to come up to full speed in approximately eleven seconds after a fire alarm has been turned in, their operation has been very satisfactory. The total cost of the fire-service station was $179,000, of which $19,300 was for real estate, $72,000 for the building and $88,000 for the equipment. Both the suction venturi meters were checked on each test against readings taken on a 4 3/8-in. test nozzle that had been calibrated by the Allis-Chalmers Manufacturing Co. and found to have a coefficient of 99

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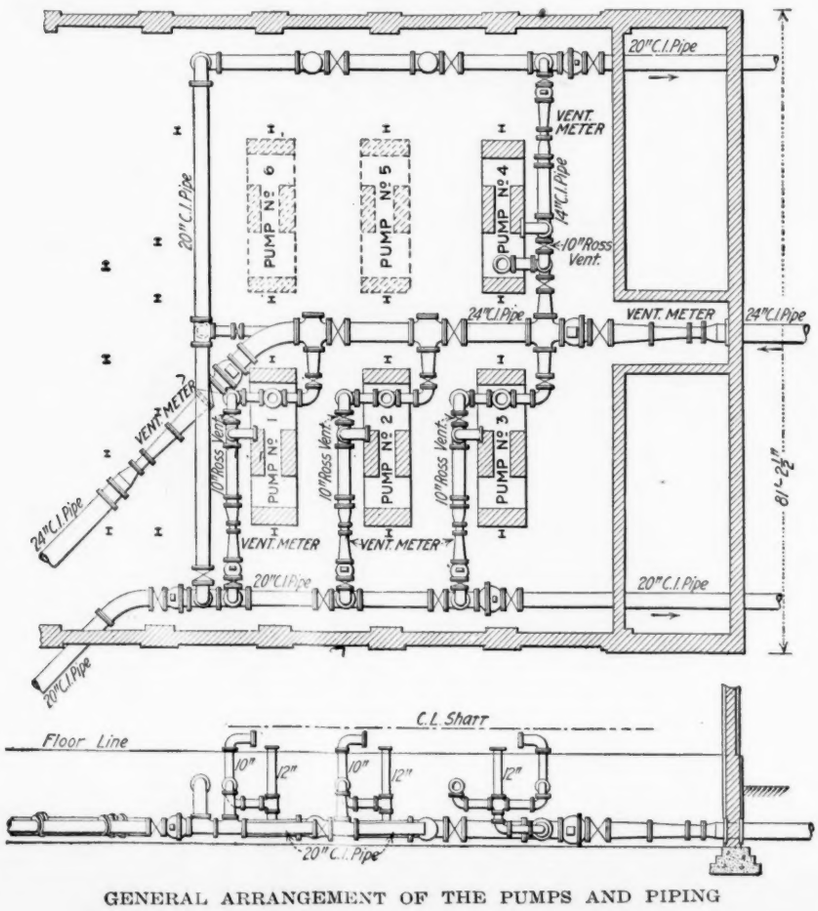
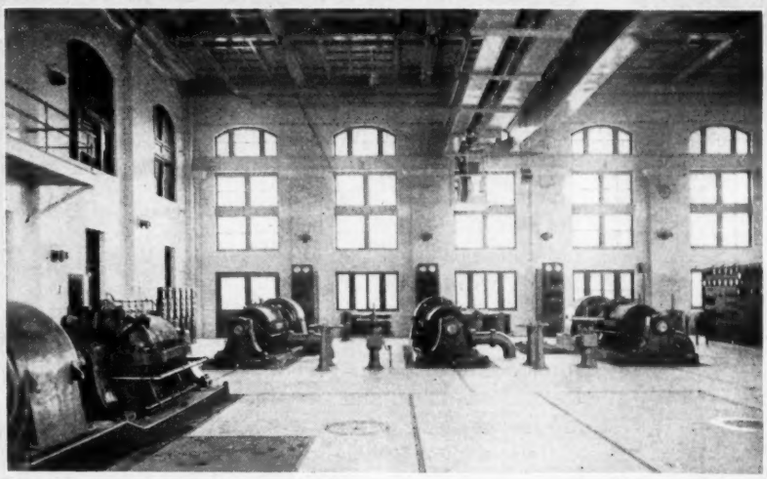
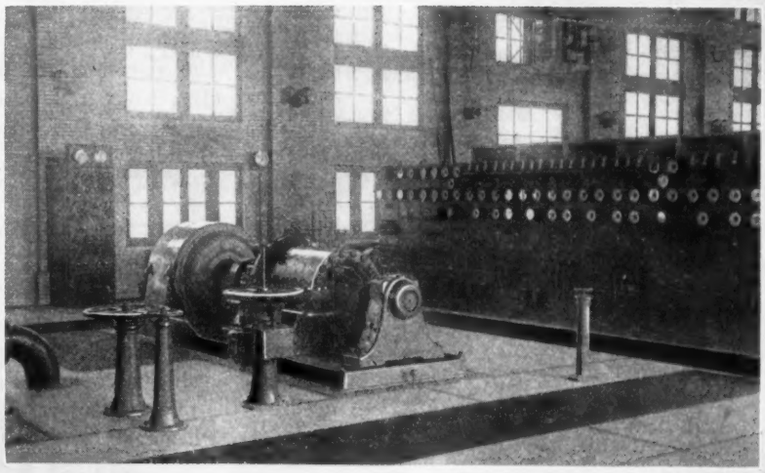


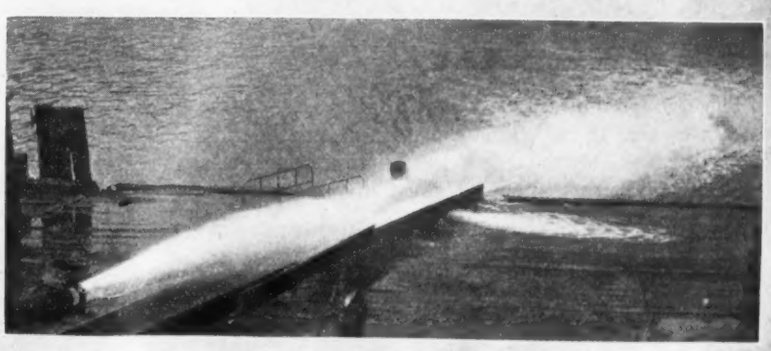
GENERAL ARRANGEMENT OF THE PUMPS AND PIPING

per cent. This nozzle, shown in section herewith, was approximately 5000 ft. from the pumping station at the end of a 12-in. high-pressure main and discharged into the Cuyahoga River, as shown. Both nozzle pressure and pitot-tube readings were taken on a mercury manometer 10 ft. in height.

The leakage from the high-pressure main, after all the valves were shut off from the branch lines between the pumping station and the test nozzle, was 1 cu.ft. in 5 min., with a pressure difference between the high-pressure main and the branch lines of 40 lb. On the pump tests the pressure difference was approximately 20 lb., so the leakage was still less and negligible. It was noted on the endurance run that the sum of the four discharge venturi readings exceeded the readings of the suction venturi meter which was in use, by several per cent., in spite of the fact that the same volume of water was being measured. Tests were run with two pumps in operation in order to give a reasonably large reading on one of the 24 in. suction meters, and the suction and discharge meters were checked against each other, also the test-nozzle pressure and pitot-tube readings. The results of these tests under several different conditions of volume discharged are given in Table IV.







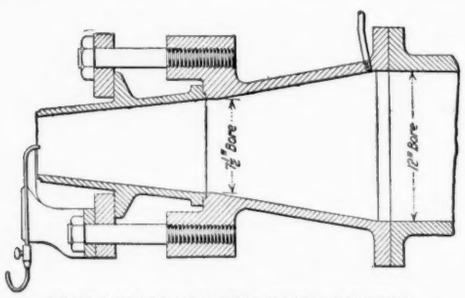
VIEWS OF THE PUMPS AND WATER DISCHARGE INTO THE RIVER

Tests 1, 2, 3 and 6 were run using the south suction venturi meter and tests 4 and 5 were run using the north suction venturi meter. Readings *d*, taken by the pitot tube shown, checked remarkably with the nozzle-pressure readings *e* taken at the top connection at the right. The nozzle readings *d* and suction venturi-meter readings *b* and *c* checked within less than ½ per cent., with the exception of test 3. In all these tests, however, the discharge meters over-registered from 3.83 to 14.92 per cent. when checked against either suction meter or the nozzle. All venturi, pitot-tube and nozzle pressures were taken with mercury manometers in order to eliminate any errors due to the use of registering devices. On tests 3 and 4, on which the greatest over-registration occurred, a small, rapid fluctuation of the mercury columns in the discharge venturi manometers was noticed, and from this the conclusion was drawn that the water was flowing through the meter tubes in swirls or waves, which had the effect of increasing the differential pressure between the upstream and throat-pressure chambers. All meters were installed with 5.2 diameters of straight pipe in front of them, but owing to the fluctuations previously noted, it was decided to install some type of vane in the upstream 6-ft. section of the 14-in. pipe in front of the venturi meter in order to determine whether this would correct the over-registration. A steel vane 3 ft. in length, as shown here in detail, was installed in this 6-ft. section between the tee and meter tube of meters 2 and 3. Tests 7 and 8 were then run, from the results of which it can be seen that the discharge meters checked closely with the suction meters after the vanes had been installed. Vanes were then installed for pumps Nos. 1 and 4, and the discharge meters then checked with either suction meter and fluctuations were eliminated.

The downstream ends of the discharge venturi meters are 22½ in. shorter than the standard, making the overall length of the tubes 8 ft. 2½ in. instead of 10 feet, 2

TABLE III. RESULTS OF EFFICIENCY TESTS

Pump number	I	II	III	IV
Test number	1	3	4	5
Duration of test, min	70	40	30	30
Average Pressures:				
Average discharge pressure at pump, lb	293.5	296.0	296.0	295.0
Average discharge head at pump, ft	678.0	683.7	683.7	681.4
Average suction pressure at pump, lb	39.5	40.5	40.5	40.5
Average suction head at pump, ft	91.2	93.5	93.5	93.5
Increase of pressure due to pump, lb	254.0	255.5	255.5	254.5
Increase of head due to pump, ft	586.8	590.2	590.2	587.9
Average suction pressure on supply main, lb	40.0	41.0	42.0	43.0
Pitot-Tube Readings and Pump Speed:				
Average pitot tube reading, gal. per min	2,819	2,774	2,878	2,925
Average pump speed, r.p.m	1,181	1,182	1,183	1,184
Economic Results:				
Average w.hp. based on pitot tube	418.5	413.8	429.3	434.6
Average e.hp. input	606.1	602.4	633.3	625.5
Combined pump and motor efficiency based on pitot tube, per cent	70.0	68.7	67.8	69.5
Average b.hp. developed, based on 94 per cent. motor efficiency	569.7	566.3	595.3	588.0
Pump efficiency based on nozzle and 94 per cent. motor efficiency, per cent	74.4	73.2	72.1	73.9



SECTION THROUGH TEST NOZZLE

CONSTRUCTION OF 3-FT. STEEL VANE

in. The diameter of the upstream piping is 14 in. and the downstream, 12 in. This shorter and smaller downstream tube probably increases the friction loss through the meter, but has no apparent effect upon its accuracy.

TABLE IV. TESTS CHECKING VENTURI METERS

Obs. No.	Gals. per Min. Delivered by Pumps Determined by: Sum of Readings on Venturi Meters Nos. 2 and 3	South Suction Venturi, 24 In.	North Suction Venturi, 24 In.	Pitot Tube and Test Nozzle	Nozzle Pressure by Mercury Column	Per Cent. Error between Venturis 2 and 3 and Suction Meters	Per Cent. Error between Venturis 2 and 3 and Pitot and Nozzle	Per Cent. Error between Suction Venturi and Pitot and Nozzle
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1	6,017	5,800	.....	5,781	5,784	+ 3.74	+ 4.03	+0.33
2	6,724	6,480	.....	6,460	6,460	+ 3.77	+ 4.09	+0.31
3	4,600	4,050	.....	4,001	4,005	+13.56	+14.97	+1.21
4	4,625	.....	4,050	4,032	4,032	+14.20	+14.71	+0.44
5	5,900	.....	5,683	5,675	5,680	+ 3.83	+ 3.96	+0.14
6	5,798	5,550	.....	.....	.....	+ 4.47	.....	.....
	Readings Taken After Vanes Were Installed							
7	4,015	4,000	.....	.....	.....	+0.65	.....	.....
8	6,510	6,500	.....	.....	.....	+0.15	.....	.....

Maintaining the Air Supply for Air-Cooled Transformers

By M. A. Walker

While considerable discussion has centered around the use and limitations of air-cooled transformers, they continue to be used largely for voltages up to 33,000 and capacities of 1000 kv.-a. The passage of air through this type of equipment is absolutely necessary if excessive temperatures and harm to the insulation are not to result, and while operation without air may not cause hot spots in the windings, the practice is risky and not to be encouraged. Since so much depends upon the air supply, and maintaining it uninterrupted from the time the transformer is cut into circuit, some of the ways a continual supply can be assured, by making noticeable the fact that the unit has been cut in without starting the air, or opening up the passages that allow it to pass through the transformer, will be of interest.

There are three things to bear in mind about the air supply; namely, that it is turned on when the transformers are placed in service, that air can pass through them if available, and that the air supply may cease for any one of many reasons.

One common scheme to assure the transformers having a supply of air is to connect a motor-driven blower directly to the transformer, so that when the transformer is excited the blower starts up. The objection to this scheme is that it is uneconomical of blower capacity and space and represents a heavy investment. Where more than one bank of air-cooled transformers are in a station, it is good practice to install two blowers, each connected so as to permit its being connected to either bank of transformers.

Protecting the Blower Motors

Instead of protecting the blower motor by fuses, it is better to use small circuit-breakers, as this prevents the motor shutting down without knowledge, since the breaker can be equipped with an alarm. The same result can be obtained by using a pressure alarm in the air duct leading from the blower, so arranged that when the air supply fails, a bell rings. The circuit-breaker with an alarm attached is better than the air alarm, because with the latter, when the fan is shut down, the bell circuit may be cut off and the attendant, when starting the fan again, may forget to turn on the alarm. Another scheme to insure starting the fan when the transformers are cut in consists of installing auxiliary contracts upon the oil switch controlling the transformers so that either the fan is automatically started or the bell circuit closed when the unit is put into service.

To prevent the needless waste of air, it is the custom to close the top and side dampers of the transformers when they are not in use. Damage may easily result if these dampers are not opened soon after the transformer is made alive. It is therefore imperative that the dampers are open and that air is passing through them as soon as the unit is in service. A good practice is to make a round every hour during light loads and every half-hour during heavy loads to make sure that the temperatures are not becoming excessive. A very effective way of indicating whether the air is passing through the top and sides of a transformer is to erect a little windmill on the top made of two pieces of wood and a couple of feathers or thick paper. As long as the windmill goes

round, it is known the air supply is on. Another equally effective way to do this is to merely tie a piece of cotton tape to the side of the transformer where the air comes out, so that it blows out straight as long as the air continues to come out. The same thing can be done on the top, it being then best to tie both ends of the tape to the transformer, leaving some slack to blow out. A station attendant soon becomes accustomed to looking at these telltales, and thus a close watch can be maintained on the air supply. In addition to these methods of keeping an eye on the air, it is important to go round occasionally and put your hand where the air comes out, to make sure that the air is cool.

Another scheme for the individual transformer consists in installing a U-tube partly filled with oil, where it can be easily seen by the attendants, and connected to the air duct by a piece of flexible tubing. If the U-tube is calibrated in inches, the operator can always see what air pressure exists in the transformer, thus assuring him that normal conditions exist.

In installing indicators, whether visual or alarm, for attracting attention or merely indicating the condition of the air supply, it is well to remember that the attendants should be relieved of all unnecessary burdens, and at the same time not have everything automatic, lest they depend entirely upon telltale devices. Alarms are often distracting and, if relied upon too much, may lead to disaster when they go wrong. Buzzers, bells or red lights may be usefully employed, the idea of them all being to safeguard the apparatus.

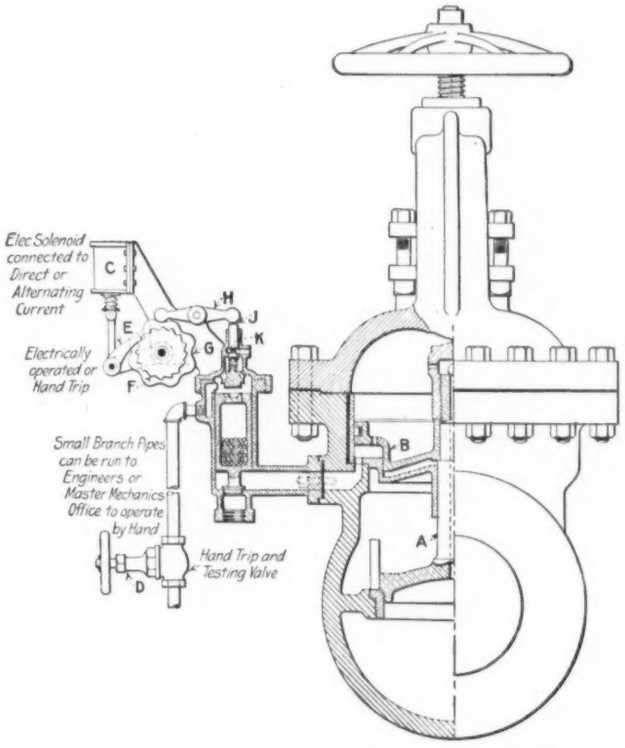
Electrically Operated Pilot Valve

Numerous methods have been devised for tripping and resetting nonreturn valves. One that should appeal to power-plant engineers has been developed by the Golden-Anderson Valve Specialty Co., Pittsburgh, Penn. The arrangement consists of a double-cushioned quick-closing nonreturn valve to which is connected a pilot valve. The special feature centers around this pilot valve and the solenoid arrangement, which is so designed as to eliminate the necessity of resetting the pilot valve by hand and also avoids any wastage of electrical energy, the solenoid using current only for a few seconds during the opening or closing of the valve.

When the pilot valve is tripped either by hand or by electric operation, the pressure between the dashpots of the trip valve is allowed to exhaust and the initial steam pressure passes through a bypass in the valve stem *A* to the space above the dashpot *B*, closes the main valve and cuts off the flow of steam to the line, as shown by the accompanying illustration. When the pilot valve is allowed to close, either by sending current through the solenoid *C* or by closing the valve *D*, the pressure builds up and equalizes on both sides of the trip valve, when it opens automatically.

The action of the pilot valve is as follows: Full header pressure is carried on the top of the weighted piston. Should a break occur in the main steam line, the pressure is removed from above the piston and the boiler pressure below the valve disk opens the valve and allows the pressure between the dashpots of the trip valve to exhaust. This action causes the main valve to cut off the flow of steam from the boiler. Opening the hand valve *D* produces the same result, likewise throwing the switch controlling the current to the solenoid. The electrical apparatus consists of a solenoid that actuates the pawl *E* that engages with the ratchet *F*, to which is secured the cam wheel *G*.

One end of the arm *H* engages with the cam wheel *G*, and the other end comes in contact with the valve spindle *J*. Throwing the switch causes the solenoid to revolve the ratchet and move the tumbler wheel so that the end of the arm *H* will be lifted from the depression on the rim to the highest point of the cam. The next throwing of the switch revolves the tumbler wheel another notch,



ELECTRICALLY CONTROLLED PILOT VALVE

and the end of the arm *H* drops into the depression of the tumbler. As the other end of the arm rests on the end of a valve stem *J*, the valve *K* is either forced from its seat, thus allowing pressure to escape from above the plunger, or the valve is forced against its seat by a spring, thus shutting off the escape of steam. In the latter case the pressure will build up above the piston and force the pilot valve closed. The trip valve will then open, admitting steam to the mains.

It is seen from the foregoing that the valve may be tripped from remote points either electrically or by the emergency pipe connection, a feature that should appeal to the operating engineer.

Separable Character of Lighting Plant—A milling company utilized its water power for the double purpose of operating the mill and also a light plant. The dynamos were fastened to the mill timbers by bolts and connected with the line-shaft of the mill by belts. During a period of several years the lighting plant had been treated as personal property, by the giving of chattel mortgages covering it, whereas the mill proper had been covered by distinct real-estate mortgages. Under these circumstances, the United States Circuit Court of Appeals, Eighth Circuit, decides that a holder of one of the real-estate mortgages, who previously knew the facts stated, was not entitled to claim the lighting plant as fixtures of the real estate covered by his mortgage. (Williamson vs. City of Clay Center, 237 Federal Reporter, 329).

Combination Absorption and Compression Refrigeration Systems

By B. Thoens*

SYNOPSIS—Describes how the absorption and compression systems of refrigeration may be combined so that the compressor operates on the high-pressure side of the system while the absorber operates on the low-pressure side, giving the advantages of a high suction pressure to the compressor and a low generator pressure for the absorption side of the system.

There are certain principles regarding compression and absorption refrigeration machines which may be summarized as follows:

First—Other conditions the same, the efficiency of the compression machine increases with increased suction pressure. See Fig. 2 and Table II.

Second—With increased suction pressure the tonnage of compression machines increases at a higher rate than the horsepower (see Table I), therefore, at constant tonnage the horsepower decreases. See Fig. 2 and Table III.

Third—Other conditions the same, the efficiency of the absorption machine increases with decreased generator pressure.

The conditions in the generator of an absorption machine when operating with high and low pressures are given in Table IV.

To realize the advantages of these principles, it would be necessary to operate compression machines with high suction pressure and absorption machines with low generator pressure. Where the two systems work independently, this is impossible, as high suction pressure in compression machines prevents low temperature in the refrigerator, and low generator pressure in absorption machines demands cooling water of unobtainably low temperature.

By a combination of the two systems under the author's cycle of refrigeration, using the compression system of operating the high-pressure side and the absorption system for operating the low-pressure side, the two systems supplement each other and each, with the aid of the other, performs that function of operation for which it is best adapted, thus operating the machine under the paradoxical condition of low refrigerator pressure and high suction pressure. The system is shown in Fig. 1.

The following is a description of the operation:

A compression machine compresses ammonia gas which, by cooling in a condenser, becomes a liquid. This liquid, passing through an expansion valve, is reëvaporated in a refrigerator, thereby cooling the surroundings. The expanded gas then passes into the absorber of the absorption system. Here the gas is absorbed in a weak solution coming from a generator, thus forming a strong solution which is forced by a pump through an exchanger back into the generator.

TABLE I. TONNAGE AND HORSEPOWER OF COMPRESSION REFRIGERATION MACHINE WORKING WITH HIGH AND LOW SUCTION PRESSURES

Suction Pressure		Horsepower Condenser Pressure 135 Suction Pressure			Horsepower Condenser Pressure 150 Suction Pressure			Horsepower Condenser Pressure 165 Suction Pressure			Horsepower Condenser Pressure 180 Suction Pressure		
High Thoens Cycle	Low Standard Machine	Tons	High Thoens Cycle	Low Standard	Tons	High Thoens Cycle	Low Standard	Tons	High Thoens Cycle	Low Standard	Tons	High Thoens Cycle	Low Standard
60	9	224	101	246	194	99	223	179	100	215	161	100	209
70	13	254	99	254	221	100	232	203	100	223	183	101	220
80	16	284	99	256	247	101	235	227	100	227	204	100	224
90	20	314	101	251	273	101	246	251	100	239	226	99	226

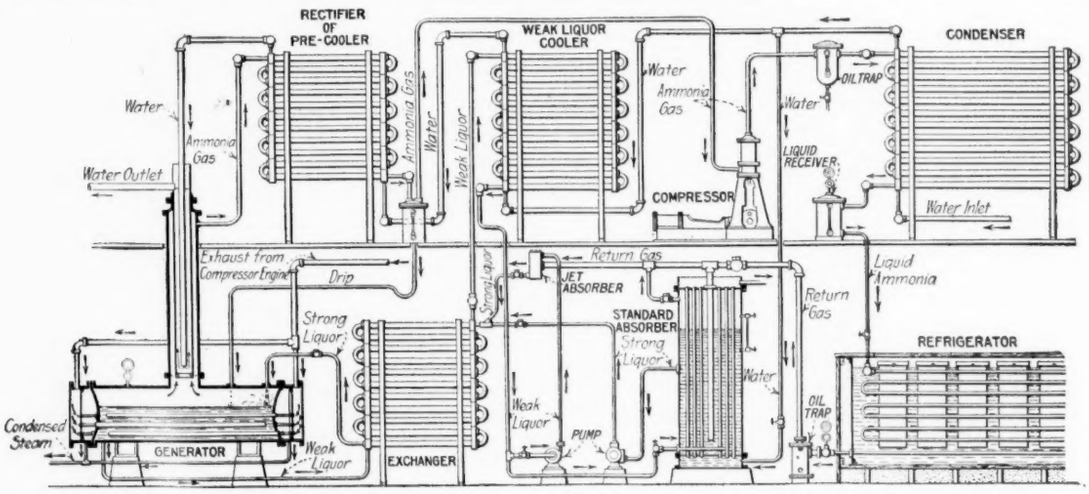


FIG. 1. COMBINATION COMPRESSION AND ABSORPTION SYSTEM OF REFRIGERATION

In the generator the gas is expelled from its solution and partly compressed by the heat of exhaust steam from the compressor engine and from auxiliaries. On its way from the generator to the suction of the compressor, the gas is partly cooled and dehydrated by passing through a precooler.

It is well understood that high suction pressure in compression machines means a small compressor and

*Consulting engineer, New York City.

small engine for a large capacity; it also means small loss for a given volume of gas due to cylinder clearances. The heat of compression being low, losses due to superheating are minimized and less gas is decomposed. Moisture and oil are kept out of the ammonia gas by the same means used successfully in fractional distillation.

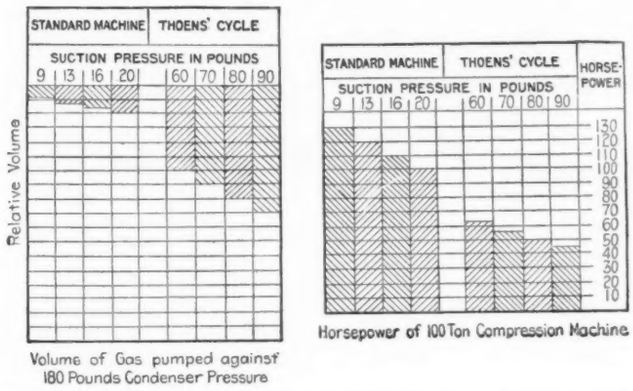

STANDARD MACHINE
THOENS' CYCLE
SUCTION PRESSURE IN POUNDS
9 13 16 20 60 70 80 90
Relative Volume
Volume of Gas pumped against 180 Pounds Condenser Pressure
STANDARD MACHINE
THOENS' CYCLE
HORSE-POWER
SUCTION PRESSURE IN POUNDS
9 13 16 20 60 70 80 90
130 120 110 100 90 80 70 60 50 40 30 20 10
Horsepower of 100 Ton Compression Machine

FIG. 2. RELATIVE VOLUMES PUMPED AND POWER REQUIRED BY STANDARD AND THOENS SYSTEMS

The advantages to the absorption system are: First, low pressure and low temperature in the generator, precluding moisture in the gas and preventing decomposition; second, for heating the ammonia in the generator, low-pressure steam is required. See Table IV.

The combination is shown in Fig. 1, in which a standard absorption machine is combined with a standard compression machine. A jet absorber has been added, which is operated by a rotary pump. The return gas is absorbed by the cooled weak solution forced by the pump through the jet and through an exchanger into

TABLE II. THEORETICAL CAPACITY IN TONS OF 100 TONS LOW SUCTION-PRESSURE COMPRESSION REFRIGERATION MACHINE WHEN OPERATING WITH HIGH SUCTION PRESSURE

Thoens Cycle High Suction		Standard Machine Low Suction Pressure and Temperature			
		90-Lb.	13-Lb.	16-Lb.	20-Lb.
		−10 Deg. F.	−5 Deg. F.	0 Deg. F.	5 Deg. F.
		Increased Capacity in Tons by Thoens Cycle with Condenser Pressure, Lb.			
Temp. Deg. F.	Pressure, Lb.	135	150	165	180
100	60	224	194	179	161
100	70	254	221	203	183
100	80	284	247	227	204
100	90	314	273	251	226

TABLE III. HORSEPOWER OF ENGINE OF 100-TON COMPRESSION REFRIGERATION MACHINE OPERATING HIGH AND LOW SUCTION PRESSURES

Standard Machine With Low Suction Pressure						Thoens Cycle With High Suction Pressure					
Suction		Condenser Pressure, Lb.				Suction		Condenser Pressure, Lb.			
Temp. Deg. F.	Pressure, Lb.	135	150	165	180	Temp. Deg. F.	Pressure, Lb.	135	150	165	180
		Horsepower						Horsepower			
−10	9	110	115	120	130	100	60	45	51	56	62
− 5	13	100	105	110	120	100	70	39	45	49	55
0	16	90	95	100	110	100	80	35	41	44	49
5	20	80	90	95	100	100	90	32	37	40	44

TABLE IV. CONDITIONS IN GENERATOR OF ABSORPTION MACHINES WHEN OPERATING WITH HIGH AND LOW PRESSURES

Thoens Cycle				Standard Machine		
Weak Liquor in Generator	Low Generator		Steam Pressure	High Generator		Steam Pressure
Deg. Baumé	Pressure, Lb.	Temp. Deg. F.	in Coils, Lb.	Pressure, Lb.	Temp., Deg. F.	in Coils, Lb.
22	60	204.1	1	135	253.3	22.5
22	70	212.6	4	150	260.2	27.5
22	80	220.4	7	165	266.3	32.0
22	90	227.4	9	180	271.5	36.0
23	60	199.0	1-in. vac.	135	248.2	20.0
23	70	207.5	2.5	150	255.1	24.0
23	80	215.3	4.5	165	261.2	28.5
23	90	222.3	7.5	180	266.4	31.5

the generator, and as the strong solution formed is not cooled, the heat of absorption is retained and returned into the generator.

The pump has the same suction and discharge pressure, requiring, therefore, little power for operating it; it has only to overcome the friction head. Any gas not absorbed in the jet absorber passes automatically into the standard absorber.

The accompanying tables have been prepared with a view of showing what can be accomplished by the combination. By converting a standard absorption or compression machine to operate on this cycle, the capacity can be more than doubled without appreciably increasing the coal consumption, or the same output can be secured with considerably less than the present coal consumption.

The author believes that this cycle offers the opportunity of producing ice and cold storage with exhaust steam from industrial plants such as water-works, power houses, factories, hotels, electric-light plants, etc.

The author would be pleased to read in *Power* constructive criticism of the system.

The Hydrostatic Boiler Test

By R. B. Dale

Most boiler requirements and inspection laws demand that every boiler be subjected to a hydrostatic pressure test before it is put into service. The purpose of this test is to detect any defective work or material in the boiler that has not been detected by other means. It is also useful in showing up leaky seams and connections.

The requirements of the various inspection laws differ somewhat as to the intensity of this test. The A. S. M. E. Code specifies that the boiler shall be subjected to a hydrostatic pressure test equal to one and one-half times the maximum working pressure for which the boiler is built. Other laws may require as much as twice the normal working pressure for the test.

The hydrostatic test is severe and the advantage of using more than one and one-half times the normal working pressure is not apparent. Excessive pressure places the material under extraordinary strains and the pressure is liable to be carried to a point where a permanent set will take place and the elasticity of the material be destroyed.

The importance of exercising care in making the hydrostatic test cannot be overemphasized and many erectors, owners and operators do not fully understand the importance of giving every consideration to the means and methods of applying this test. As an illustration of what wrong methods may do, one engineer when testing an air tank, left the pressure on for four hours. Although the seams were tight at the beginning, they were leaking at the end of the period. The riveted joints had not been able to withstand the prolonged pressure, the tank had been injured, and no benefit had been gained by leaving the pressure on for this period. Another erector left a boiler overnight with the test pressure on. The boiler was out in the open and the heat of the sun in the morning expanded the water in the boiler. Mr. Erector was much surprised to find that the hydrostatic pressure had run up 100 lb. overnight.

The writer believes that in general a steam boiler should be subjected to a hydrostatic test equal to one and one-half times the ordinary working pressure but once during its ordinary lifetime. There is nothing to be gained by putting on this pressure several times. If a boiler has undergone major repairs, such as part of the shell cut out and

a patch put on, or a new water-leg furnished to a water-tube boiler, or some extensive repairs of a similar nature, the boiler should again be subjected to a hydrostatic test one and one-half times the normal working pressure, and such repairs are legitimate reasons for applying the test. If there is reason to suspect, by internal or external examination, that the boiler is liable to fail under its normal working pressure, it is advisable to apply a hydrostatic test equal to one and one-half times the pressure which the inspector will allow. If the boiler withstands this test without showing distress, it may be taken as evidence, contributory but not conclusive, that the boiler is capable of handling the steam pressure which the inspector advises under such conditions.

For a new boiler of the fire-tube type, the application of the hydrostatic test at the factory to one and one-half times the normal working pressure, in the presence of an authorized inspector, should be sufficient evidence that such test had been properly applied, and it should not be necessary to apply the test again, except when major repairs are necessary, or for any reason the safety of the boiler is questioned after it has been in service for a considerable time.

For boilers of the water-tube type, which are shipped in sections, the hydrostatic test is applied after the boiler has been erected and the tubes properly inserted and expanded. To make this test all openings of the boiler should be closed except the one that is connected to the hydraulic pump. This connection is usually made through the feed-pipe connection. The adjustment of the safety valves should not be changed by increasing the tension on the springs, because this is liable to overstress the springs and thus injure them. It would also be troublesome to bring the adjustment of the pop valves back to the normal working pressure. The safety valves should be entirely removed and blank flanges placed on the openings. A regular inspector's clamp could be used if available. Do not insert a blind gasket between the flange and the valve. This is not considered good practice, for the reason that this gasket may be forgotten and left in place after the erector has turned the boiler over to the owner. Such an incident might lead to serious results.

Preliminary Testing

For the preliminary test, a pressure equal to the working pressure for which the boiler was designed, as indicated on the gage, should be put on by the erector before he calls in the insurance inspector. The erector should then go over the boiler very carefully and examine it for leaky tubes, seams, joints or connections. This pressure should be kept on only long enough to make a complete and careful examination. It should then be removed, and any leaks that may have appeared should be made tight by calking or otherwise. When the erector is satisfied that the boiler is tight, he should notify the insurance inspector or the boiler inspector having local jurisdiction. The boiler should then be subjected to a hydrostatic test of a pressure equal to one and one-half times the normal working pressure, in the presence of such an inspector. For example, if the boiler is designed for 160 lb. working pressure (gage) the hydrostatic pressure should be 240 lb.; or if it is designed for 175 lb. working pressure, the test should be for 262 lb. The boiler should again be examined carefully for leaks, both by the erector and by the inspector, and the latter should satisfy himself that the boiler is tight. This test pressure should be kept on only long enough to make a thorough examination of the boiler. This, in most cases, can readily be done in one hour's time.

The water used for testing should be at the same temperature as the metal of the drums or as nearly the same as possible. This is to prevent expansion and contraction due to temperature differences. In freezing weather every precaution should be taken to prevent the freezing of the water in the boiler and the boiler and all connections should be thoroughly drained after the test is completed. The erectors should never go away from the boiler and leave it under hydrostatic pressure. Never leave a boiler overnight, nor for any considerable period of time under the hydrostatic test.

The Law of Partial Pressures

By H. J. Macintire

The law of partial pressures has a number of common engineering applications and should be a subject of general knowledge, for quite frequently we have to deal with mixtures of different gases—such as steam and air in the cooling towers and in surface condensers, air or disintegrated ammonia in the ammonia condensers, or steam and ammonia in the analyzer and dehydrator of absorption refrigerating machines. The method of solution for a few of the problems embodying these principles may therefore be interesting.

Dalton's law, or the law of partial pressures, is stated as follows: When two or more vapors or gases are mixed, the pressure of the mixture is equal to the sum of the pressures which each would exert if it occupied the volume alone. That is, $p = p_1 + p_2$, where p is the total pressure and p_1 and p_2 are the partial pressures. These gases tend to become intimately mixed, according to the law of diffusion, but frequently this is not so, as one will notice in the case of the steam condenser.

Case 1. Air and Steam in a Surface Condenser—Given 90 deg. F. as the temperature of the interior of a surface condenser, and the pressure 2.5 lb. abs., find the density of the air present. What would its density be at 80 instead of 90 deg.? First find the pressure of saturated steam at 90 deg. F. This from the steam tables is 0.696 lb. and is p_1 in the formula. Then if $p = 2.5$, the total pressure, $p_2 = p - p_1$, or the pressure exerted by the air $= 2.5 - 0.696 = 1.804$ lb. and the weight of air per cubic foot, w is given by the formula,

$$p_2 \times v = wRT$$

where

T = The absolute temperature = 460 (abs. zero.) + 90;

R = The gas constant for air = 53.35;

v = 1 cu.ft.; p = 1.804×144;

p_2 = Air pressure per square foot = 1.804×144

$$w = \frac{p_2 v}{RT} = \frac{1.804 \times 144 \times 1}{53.35 \times (460 + 90)} = 0.00886 \text{ lb.}$$

Likewise the density at 80 deg. is 0.01 lb. The density at atmospheric pressure, it may be stated, is $\frac{1}{13.1} = 0.0764$, for a temperature of 60 deg. F.

Case 2. A Mixture of Air and Ammonia—Air or foreign gases collect in the ammonia condenser (as they can-

not condense with the ammonia, and after a week or two of operation they modify the action of the plant considerably owing to increased pressure—which means more work required of the prime mover—and decreased efficiency of the condenser because less heat is conveyed through the condenser pipes when air or inert gases are present. Given, then, a condenser temperature of 70 deg. F. and a pressure of 150 lb. gage (164.7 abs.), find the excess pressure due to the presence of the air.

As the ammonia is saturated (superheated ammonia is present only when the compressor is working and then only at the top of the stand of pipes), the pressure of the ammonia alone at 70 deg. from the ammonia tables is 129.2 lb. abs., therefore, as before

$$p = p_1 + p_2, \text{ or } 164.7 = 129.2 + p_2$$

and

$$p_2 = 164.7 - 129.2 = 35.5 \ lb.$$

Case 3. Mixture of Steam and Ammonia—The generator of an absorption machine is like any other still, and when heat is applied to the strong aqua (the solution of ammonia in water), both steam and ammonia are driven off. The partial pressure of the steam is that corresponding to the temperature, for it is the steam, here, which is saturated. The ammonia is in a superheated state until it reaches the condenser, the superheat being greatest in the generator and the analyzer. If the mixture leaving the dehydrator has a temperature of 105 deg. F. and the pressure is 185 lb. abs., find the partial pressure of the steam vapor and prove that water will be condensed with the ammonia in the condenser. First, we know that the steam in the dehydrator is saturated and that the ammonia is superheated—the amount of superheat depending to a great degree on the temperature to which the vapor mixture is reduced. Therefore the partial pressure of the steam may be found by determining the pressure of saturation at 105 deg., which is 1.1 lb. The pressure due to the ammonia is 185 — 1.1 = 183.9, and the amount of superheat in the refrigerant is 105 — 90.7 = 14.3 deg. F. The density of the water vapor is 1 ÷ 304.7 = 0.00328, which proves that in the process of time the ammonia in the liquid receiver will collect an appreciable amount of water and the expansion coils or the brine cooler will have its operation impaired or be "put out of commission" entirely, and in consequence a "pump out" is in order to purge the system.

Case 4. Cooling Towers—In the cooling tower air must rise in contact with descending warm water and the air is warmed during the process, increasing its volume at constant pressure, and it leaves the tower with 100 per cent. humidity, due to the evaporation of a small amount of the water, the remainder of which is cooled thereby in the descent. Given a cooling tower taking air at 70 deg. and 75 per cent. humidity, the water entering the tower at 120 deg., find the density of the dry air and the water vapor at entering and leaving the tower. The pressure of the steam corresponding to 70 deg. is 0.323 lb., but as the air is only 75 per cent. humid, the partial pressure exerted is only 0.75 × 0.323 = 0.247. The weight of air present per cubic foot is found from the same formula,

$$pv = wRT$$

where

$T = 460$ (abs. zero) + 70 = 530 deg. F. abs.;

$p = (14.7 - 0.25) = 14.45$ lb. per sq.in. abs.;

$$= \frac{144 \times 14.45 \times 1}{53.3 \ (\textit{the gas constant}) \times 530} = 0.0736 \ lb.$$

On leaving, the partial pressure of the steam is 1.69, corresponding to 120 deg., and its density is 1 ÷ 203.1 = 0.0049. The density of the air is

$$w = \frac{144 \times (14.7 - 1.69)}{53.3 \times (460 + 120)} = 0.0605 \ lb.$$

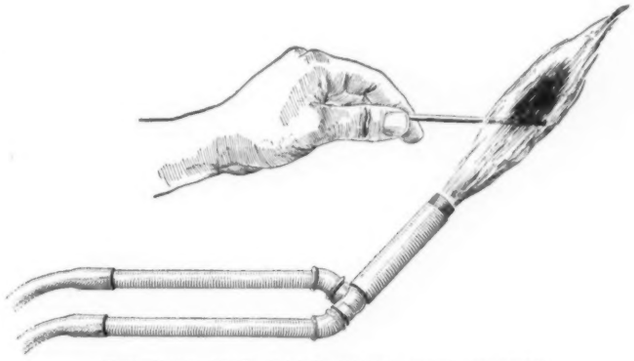
Case 5. Mixture of Air and Water Vapor in a Closed Vessel—Given a boiler partly filled with water (the remainder of the space being occupied with air) to which heat is applied. At what pressure will boiling take place? As ebullition can occur only when the vapor tension is equal to the pressure in the vapor space, the water in the boiler will never boil. (This is only of academic importance for, of course, as soon as the pressure rises to that for which the relief valve is set the air and steam will flow out.)

Testing Condensate for Salt

When salt water is used for condensing purposes, there is danger that it may find its way into the condensate, which would make it unfit for boiler feeding. This danger of impregnating the boiler feed with salt lies in the fact that condenser tubes will leak, and it does not require a very serious leak to admit enough salt water to the condensate to cause trouble in the boiler.

How is the engineer to know whether a tube has started to leak? How can he test the boiler feed for salt with success and with the least inconvenience to himself? Of course there are chemical means, but the engineer does not always have the necessary supplies at hand.

A simple method of testing for salt is by means of a blowtorch or bunsen burner and a piece of iron wire, using illuminating gas in the burner. With the burner in operation, first insert the wire to burn off any foreign matter. Then without touching the test end of the wire with the hand, dip it in a sample of the condensate and expose the dipped end of the wire to the flame. If a trace of salt is in the water, an orange-yellow spot will appear, as represented by the dark portion of the flame



TESTING FOR SALT WITH GAS FLAME

(see illustration). If there is no salt present, the flame will remain the natural blue of the burner. The tests should be made daily.

The reason it is necessary to avoid touching the test wire with the hand is because the perspiration contains salt, and if the wire were exposed to the flame the presence of the salt would show in the orange-yellow flame. If the wires, after being handled, were used to test the condensate, the result would be misleading and although the water might be fresh, the tests would show the presence of salt.

Turbine Oiling System in Essex Power Station

By A. T. Brown

SYNOPSIS—An oiling and filtering system for two 25,000-kv.-a. turbines that can be operated on either the continuous or batch principle. The filter contains 120 sq.ft. of effective filtering surface and has a maximum rated oil-filtering capacity of 830 gal. per hour.

When selecting the type of oiling system that should be adopted for the turbines in the Essex Power Station, of the Public Service Electric Co., Newark, N. J., two different designs were considered: (1) A system with continuous filtration; (2) a system with intermittent or batch filtration.

As examples of systems of the first type the company already had two large stations—the Marion Power Station in Jersey City, N. J., and the Burlington Power Station in Burlington, N. J.—where successful oiling systems of the continuous type were in operation. These two stations have a large number of vertical Curtis turbines, the oil being pumped continuously through the step bearings on these machines, from where it flows by gravity to filters which are operated continuously, thence to storage tanks, and is then pumped back through the bearings again. Incidentally the oil loses considerable of its heat in circulating through the system, additional cooling being given by means of water circulating through coils placed in the storage tanks. In this type of system large filters must be installed in duplicate, each having sufficient capacity to filter the maximum flow of oil. These large filters with their storage tanks take up considerable space in the station, and there are also continual operating charges for pumping, changing and cleaning the bags in the filter trays.

As the turbines in the Essex Power Station were each provided with a self-contained oiling system, the station's oiling system could be operated on either principle; that is, oil could be withdrawn continuously from the turbines, filtered and returned, to be passed through the bearings again, or the oil could be withdrawn entirely at certain intervals, filtered and then returned to the turbine system, no oil being withdrawn or filtered between times.

After consideration, the engineers of the company decided to design the station's oiling system on the batch principle as being the least expensive to install and to operate, also as giving results practically equal to continuous filtration.

At the Marion and Burlington stations the engineers had designed and built an economical and successful type of continuous oil filter; nevertheless, when the question of selecting a filter for the Essex station was considered, it appeared that a new filter developed by the Richardson-Phenix Co., Milwaukee, Wis., offered advantages over the continuous type already in service at the other stations. This new type of filter is very compact, the filtering units can be cleaned and changed easily and quickly, every square inch of filtering cloth has the same filtering capacity, and the water separation is effected before the oil passes through the filter cloth, thus reducing the quantity of liquid to be filtered.

Excepting for a brass-cloth strainer, the self-contained oiling systems of the main units do not provide means for taking from the oil the sediment that comes from the wear in the bearings, and the water that accumulates from leaks in the bearing seals, jackets and the oil cooler. A station system was accordingly designed which should fulfill the following requirements: (1) Provide means for withdrawing and filtering in whole or in part the oil in any one unit and replacing with new or clean oil without interfering with the operation of the unit, that is, batch filtration; (2) give storage capacity for reserve and filtered oil; (3) have facilities for receiving new oil and keeping it separate from the rest of the oil in the system until an analysis has been made to see if the oil is suitable for use; (4) system to be so designed that additional filtering or storage capacity can be provided as the station is enlarged without disturbing the existing system.

The arrangement of this system is shown in Fig. 2. The oil filter, which was specially constructed to meet the conditions in this plant, is equipped with twenty 18 x 24-in. filtering units, giving a total of 120 sq.ft. of effective filtering surface and having a maximum rated oil-filtering capacity of 830 gal. per hour. This filter is divided into two separate parts so that one part can be cleaned without interfering with the operation of the other part. The filter is placed over a storage and emergency water-separating tank of 2800-gal. capacity, which is divided into six separate compartments. In regular operation only a few of these compartments are used, but in case of an emergency which requires the immediate emptying of the turbine-storage reservoirs and there is not enough time to pass the oil through the filter, all the oil is drained to the first compartment of the storage tank and overflows into some of the remaining compartments. The separated water in each compartment is drawn off through the cocks at the bottom. The oil is then pumped

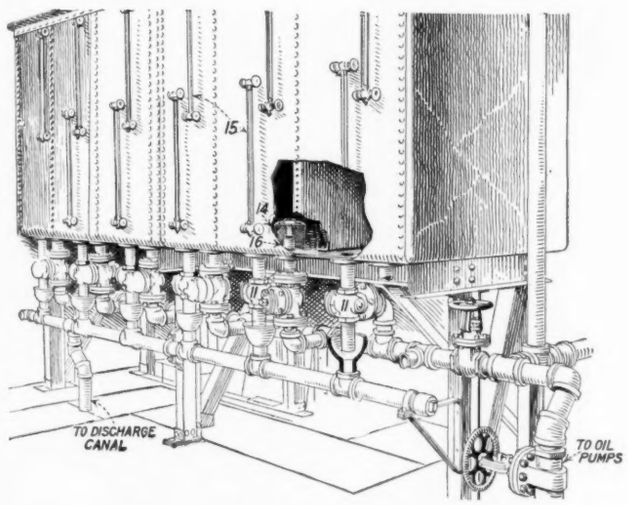


FIG. 1. ARRANGEMENT OF PIPING AROUND FILTER STORAGE TANK

through the filter and drained into an empty compartment, thence being pumped up into the overhead storage tank ready to be used again. The arrangement of the filter-storage tank and piping is shown in Fig. 1.

oil up into the storage tank *B* on the economizer floor. A sample is then sent to the company's laboratory, and if the analysis is satisfactory the oil is then allowed to enter the system from this tank as required.

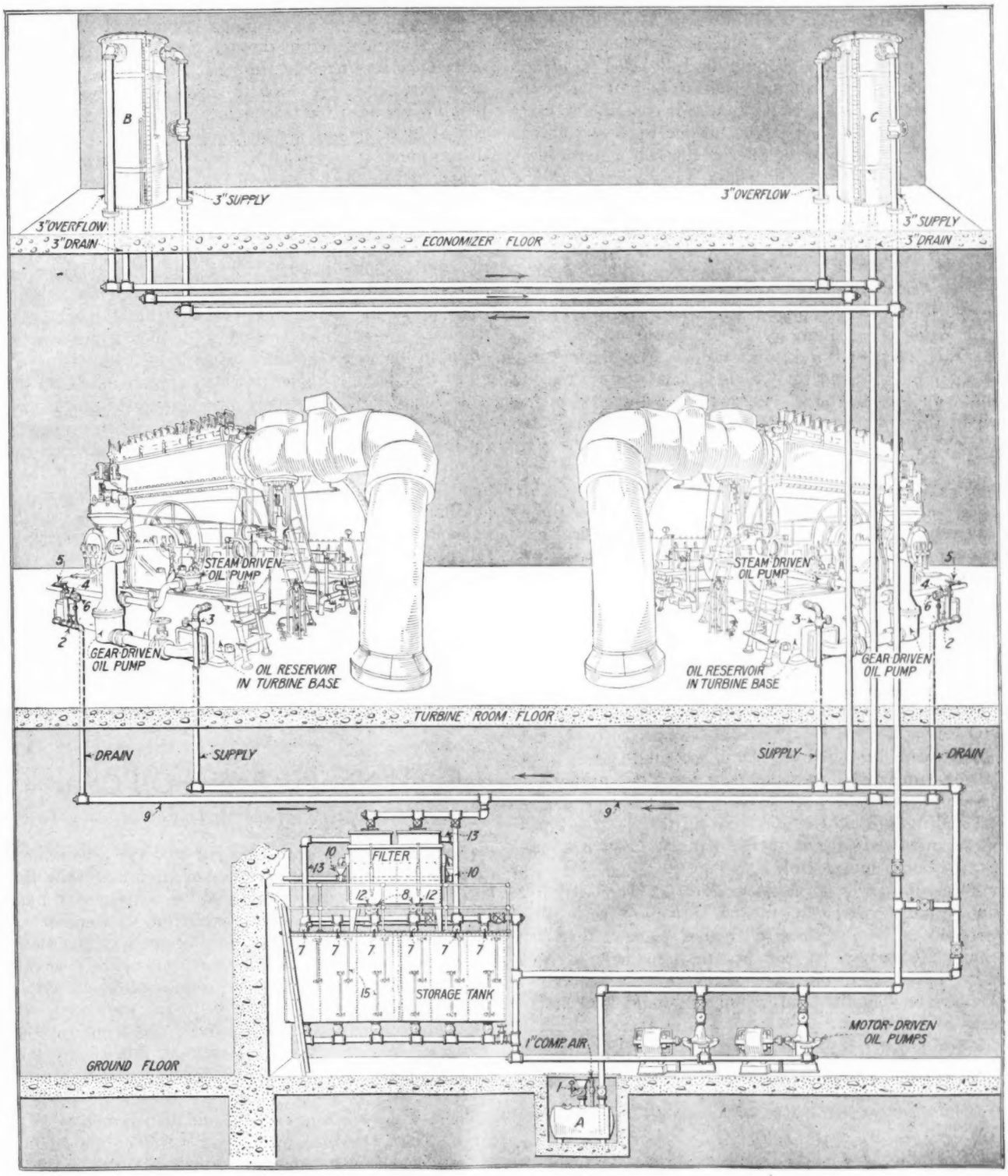


FIG. 2. PIPING AND EQUIPMENT LAYOUT OF TURBINE OILING SYSTEM

When new oil is received at the station, it is drained through a funnel into the receiving tank *A*, Fig. 2, beneath the basement floor. As soon as this tank is full valve 1 below the funnel is closed and compressed air admitted through the 1-in. pipe shown, which forces the

As shown in the figure, the oil reservoirs on the turbine are provided with valves on both the drain and overflow pipes so that this system can be operated on either the continuous- or the batch-filtration system; that is, the dirty oil can be drawn out slowly and continuously from

the bottoms of the reservoirs through the valves 2 and passed to the filter while clean oil is being continuously added on the top through the valves 3, or all the oil may be drawn at once and filtered before adding new oil.

Overflows are provided at 4, so that in case the oil rises above a certain level part will overflow down through the filter. A 1-in. vent pipe 5 is installed, as shown, on each overflow to prevent siphoning the oil below a certain point. Shut-off valves 6 are placed in each of these overflows. These are to be closed in case it is desired to carry a larger quantity of oil in the turbine bases and also to control the overflow to the filter at times of high oil level.

After passing through the filter, the oil can be turned into any of the six compartments of the tank below by valves 7 and 8, and then is passed through one of the 150-gal. per min. oil pumps and discharged into the overhead storage tank *C*.

The overflows and drains from tanks *B* and *C* are connected to the overflow pipe 9 from the turbine reservoirs and thence to the filter, so that any excess oil will automatically be passed back to the filter. The arrangement of the piping around the filter and filter storage tank is shown in Figs. 1 and 2. The water separated from the oil in the filter is drained out through the funnels 10, Fig. 2. Also by means of the three-way valves 11, Fig. 1, the contents of any one compartment of the filter storage tank can be thrown away into the discharge canal or delivered to the suction of the oil pumps. These three-way valves are to be used for draining to the canal any water that separates from the oil when the filter is bypassed, also for draining any dirty oil that may accumulate in the tank bottom to the oil pumps to be returned to the filter for cleaning. The drains 12, Fig. 2, from the dirty-oil compartments in the filter empty into the last compartment of the filter storage tank so that as much oil may be recovered as possible from the sludge before it is thrown away.

Overflow 13 from the filter is also connected to the last compartment on the storage tank so that if oil is being delivered in larger quantities than the filter can handle, the excess will flow to this compartment, no oil will be lost and in addition the unfiltered oil that overflows will not be mixed with the filtered oil in the other compartments of the storage tank.

As shown in Fig. 1, basket strainers 14 are placed over the clean-oil outlets 16, in the bottom of each compartment, to keep any coarse scale or sediment that may accumulate in the tanks from passing to the pumps. Also gage-glasses 15 are provided on the front of each compartment so that the levels of oil and water may be observed.

Steam-heating coils are placed in each filter inlet so that the temperature of the oil may be raised if desired before filtering. This reduces the viscosity of the oil, thus increasing the speed of water separation and filtration.

Great pains have been taken to secure an oiling system that is easy to keep clean and maintain in the best possible condition. Plugged tees and crosses have been used in place of elbows and tees at the end of long horizontal runs in the piping, so that all parts are readily accessible for cleaning.

On account of the present high cost of brass pipe it was decided to make all the piping in the system from Shelby seamless drawn steel tubing in order to secure a system that will give the least possible quantity of scale and rust. All the threaded pipe joints were made up with shellac, and the flanged pipe joints were made up with "Rex" vulcanized asbestos gaskets made by the Crandall Packing Co.

On each turbine an oil pump is mounted on the end of the shaft and driven through gears. This pump circulates oil continuously through the bearings while the unit is running. A separate steam-driven auxiliary oil pump is provided for the starting and shutting-down periods. Both pumps are shown in Fig. 2. The steam-driven pump is controlled by means of a governor which is actuated by the pressure in the oil-supply pipes on the turbine leading through the hydraulic governor gear to the bearings. This governor is set to shut off the steam supply to the auxiliary pump as soon as the pressure in the bearings reaches 60 lb. The normal operating pressure of the gear-driven pump on the end of the turbine shaft is 70 lb. Accordingly, at starting the unit, the auxiliary steam pump is used to develop a pressure of 60 lb. in the oil piping, then, when the machine is nearly up to full speed, a higher pressure, approximately 70 lb., is developed in the oil-supply pipes due to the gear-driven oil pump; this operates the governor on the steam supply to the auxiliary oil pump, automatically cutting the pump out of service until the unit is being shut down and the speed of the turbine is decreasing, when the auxiliary steam-driven pump again comes into service automatically as soon as the pressure in the oil piping has fallen to 60 pounds.

The actual oil pressure on the bearings of the turbine is 40 lb. per sq.in. This supply of oil is taken from the main gear-driven oil pump through a throttling valve which reduces the pressure from 70 to 40 lb. per sq.in. The pressure of 70 lb. per sq.in. is used to operate the steam-inlet valves on the turbine steam chest. These valves are under the control of the governor.

Could Not Pry Engine Off Center

By Thomas M. Gray

One afternoon we paralleled our 400-kw. alternating-current generator with the 300-kw. unit and shut the latter down. The engine stopped on center, so I took the prying bar and started to bar it off. I could move the flywheel, but the moment my weight was taken off, in order to place the bar in the next notch of the flywheel, the latter would go back to its previous position. After repeated attempts I called for help, and even with another man on the end of the bar we could not get the engine off center. The moment that the weight was taken off the end of the bar the flywheel would go back to its original position.

There was something wrong, and we started to look for it. The consensus of opinion was that the engine cylinder had run dry and the piston had stuck. About this time someone looked at the switchboard and found the field switch of the 300-kw. generator closed. The operator had thrown out the oil switch, but had forgotten to open the field switch. The result was that the rotor field poles of the 300-kw. machine were acting as powerful magnets to hold the field structure in a fixed position in the stator. Needless to say, when the field switch was thrown out, the engine pried off center easily.

The Electrical Study Course—Watts and Kilowatts

SYNOPSIS—The problems given in the previous lesson are worked out and different methods explained for calculating the watts expended or transmitted in the circuit.

The layout of Problem 1 in the preceding lesson is shown in Fig. 1. It may seem that the starting point in this problem is somewhat obscure, but if we just remember the elementary rules that have been set forth in previous lessons, it will make the solution very simple. The key to this problem is in circuit R_3. The total resistance $R_3 = 35$ ohms; r_5, one section of R_3, equals 13 ohms; then $r_6 + r_7 = R_3 - r_5 = 35 - 13 = 22$ ohms.

The volts drop across r_6 is $E_6 = 65$, and the volts drop across r_7 is $E_7 = 45$. Hence the volts drop across $(r_6 + r_7) = E_6 + E_7 = 65 + 45 = 110$ volts. This gives a condition similar to having one resistance of 22 ohms with 110 volts drop across its terminal. We know that the current flowing in any circuit may be found by the volt drop across any section of the circuit divided by the resistance of that section in ohms. Therefore, in the circuit in question, $I_3 = \frac{E_6 + E_7}{r_6 + r_7} = \frac{110}{22} = 5$ amperes. Then the volts drop across section r_5 is $E_5 = I_3 r_5 = 5 \times 13 = 65$ volts. The value of the resistance section $r_6 = \frac{E_6}{I_3} = \frac{65}{5} = 13$ ohms, and $r_7 = \frac{E_7}{I_3} = \frac{45}{5} = 9$ ohms. The total volts E equal the sum of the volts drop across the individual sections of the circuit; in this case $E = E_5 + E_6 + E_7 = 65 + 65 + 45 = 175$ volts. Checking up the work, $R_3 = r_5 + r_6 + r_7 = 13 + 13 + 9 = 35$ ohms; this is the same as the value given in the problem. $I_3 = \frac{E}{R_3} = \frac{175}{35} = 5$ amperes, which corresponds to the value previously obtained.

Values of Circuit R_2 Determined

It was stated in the question that the resistance of an ammeter is so low that we can neglect the volts drop necessary to cause the current to flow through the instrument. Consequently, the total pressure of the circuit will be effective in setting up a current through r_3 and r_4. Hence E_3 will equal $E = 175$ volts and E_4 will also equal $E = 175$ volts. $i = \frac{E_3}{r_3} = \frac{175}{17.5} = 10$ amperes, and $r_4 = \frac{E_4}{i_1} = \frac{175}{12.5} = 14$ ohms. $I_2 = i + i_1 = 10 + 12.5 = 22.5$ amperes. Then by Ohm's law the joint resistance of this circuit is $R_2 = \frac{E}{I_2} = \frac{175}{22.5} = 7.77$ ohms. By the joint resistance formula $R_2 = \frac{1}{\frac{1}{r_3} + \frac{1}{r_4}} = \frac{1}{\frac{1}{17.5} + \frac{1}{14}} = \frac{1}{\frac{45}{350}} = \frac{350}{45} = 7.77$ ohms.

The total voltage of the circuit is 175; therefore, in circuit R_1, $E_2 = E - E_1 = 175 - 79 = 96$ volts; then $I_1 = \frac{E_2}{r_2} = \frac{96}{12} = 8$ amperes; $r_1 = \frac{E_1}{I_1} = \frac{79}{8} = 9.875$ ohms; $R_1 = r_1 + r_2 = 9.875 + 12 = 21.875$ ohms.

The total current in the three circuits is $I = I_1 + I_2 + I_3 = 8 + 22.5 + 5 = 35.5$ amperes. The joint resistance for the three circuits in parallel is $R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{\frac{1}{21.875} + \frac{1}{7.77} + \frac{1}{35}} = \frac{1}{\frac{1207.5}{5948.9}} = \frac{5948.9}{1207.5} = 4.93$ ohms.

By Ohm's law the joint resistance is $R = \frac{E}{I} = \frac{175}{35.5} = 4.93$ ohms. This checks with the joint-resistance method. In this particular instance it is evident that the Ohm's-law method is much the simpler of the two.

The total watts equal the total volts times the total current; that is, $W = EI = 175 \times 35.5 = 6212.5$ watts; electrical horsepower $= \frac{W}{746} = \frac{6212.5}{746} = 8.33$ horsepower. The unit of electrical power (watt) is small, and if used in every case would give a very large and inconvenient number. To get a more convenient unit, the kilowatt (kw.) is used and is equal to 1000 watts. Hence, we may say that kilowatts $= \frac{\text{watts}}{1000}$ or $KW = \frac{W}{1000}$. In the problem under consideration the watts $= 6212.5$, then the kilowatts $= \frac{6212.5}{1000} = 6.2125$, or approximately 6 kilowatts.

We are now in a position to state what the different instruments will read. Voltmeter G, being connected

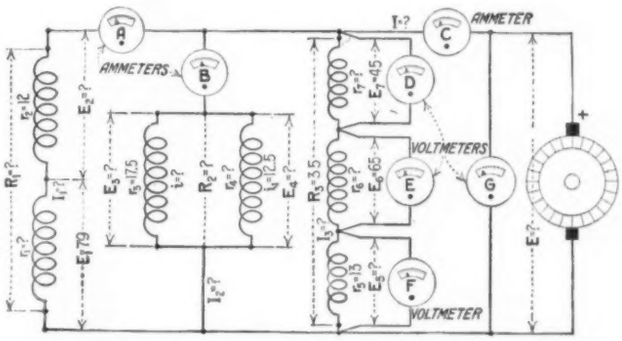


FIG. 1. ELEMENTS GROUPED IN SERIES AND PARALLEL

directly across the line, will read the total line volts, or in this problem 175; voltmeter D is connected to the terminals of resistance r_7, therefore will read the volts drop across this resistance, or 45; voltmeter E will read 65 volts, the volts drop across resistance r_6, and voltmeter F will read 65 volts, the potential across r_5. The currents of all three circuits pass through ammeter C, consequently this instrument will read the total current in the circuit, or 35.5 amperes. The current for R_1 circuit only, flows through ammeter A, hence this instrument will read the value of I_1, or 8 amperes, and ammeter B will indicate the value of I_2, the current flowing through r_3 and r_4, or 22.5 amperes.

Fig. 2 shows the condition existing in the circuit in Problem 2; namely, a 220-volt circuit with 37.5 amperes

flowing through it. The watts equals volts times the current, that is, $W = EI = 220 \times 37.5 = 8250$. Electrical horsepower $= \frac{W}{746} = \frac{8250}{746} = 11$ horsepower, and the kilowatts $= \frac{W}{1000} = \frac{8250}{1000} = 8.25$ kilowatts.

The values in Problem 3 are given in Fig. 3. Before we can find the power in watts, the current in amperes must be known. Since the value of E and R are known, the current may be determined by Ohm's law. Hence $I = \frac{E}{R} = \frac{375}{7.5} = 50$ amperes. The watts $W = EI = 375 \times 50 = 18{,}750$ watts. Electrical horsepower $= \frac{W}{746} = \frac{18{,}750}{746} = 25.3$ horsepower, and the kilowatts $= \frac{W}{1000} = \frac{18{,}750}{1000} = 18.75$ kilowatts.

The volts $E = RI$, and the watts $W = EI$. By substituting the equivalent RI for E in the second formula, $W = RI \times I = RI^2$, or, as it is usually written, $W = I^2R$. In Problem 3 the value of the resistance R is 7.5 ohms and the current I was calculated to be 50 amperes; then watts from the formula, $W = I^2R = 50 \times 50 \times 7.5 = 18{,}750$ watts. This value checks with that obtained by the product of volts and amperes, which shows that the expression is correct.

The expression I^2R (read I squared R) is very important, as it is generally used to express the heat losses

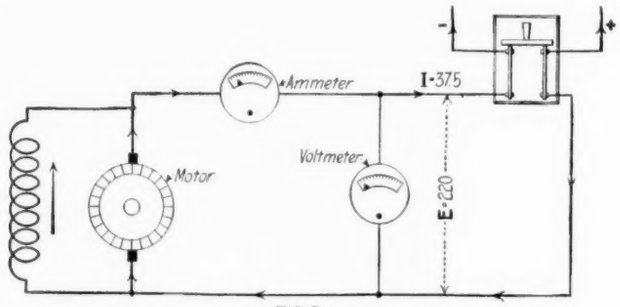


FIG. 2

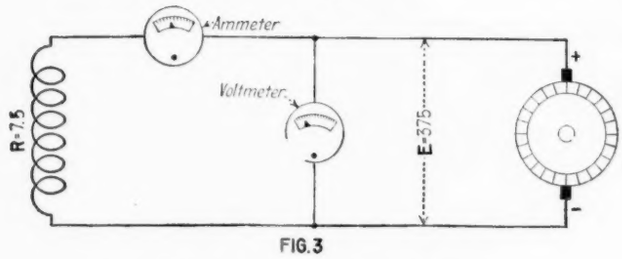


FIG. 3

FIGS. 2 AND 3. ELEMENTARY CIRCUITS

in electrical devices, these losses being referred to as I squared R losses (I^2R losses). Another expression for the watts is derived as follows: $W = EI$, and $I = \frac{E}{R}$. By substituting the equivalent $\frac{E}{R}$ for I in the formula, $W = EI$, we have $W = E \times \frac{E}{R} = \frac{E^2}{R}$; that is, $W = \frac{E^2}{R}$, or we may say that the watts equals volts times volts divided by resistance. Applying this to Problem 3, the volts $E = 375$, and the resistance $R = 7.5$, then $W = \frac{E^2}{R} = \frac{375 \times 375}{7.5} = 18{,}750$; this is the same as obtained by the other two methods.

The formula $W = EI$ may be transposed to read $E = \frac{W}{I}$ for obtaining the volts when the watts and current is known; also $I = \frac{W}{E}$ From this latter the current can be obtained when the watts and volts are given. Taking the value for $W = 18{,}750$, and $I = 50$, given in Problem 3, the value of $E = \frac{W}{I} = \frac{18{,}750}{50} = 375$ volts, as given in the problem. Again, the value of $I = \frac{W}{E} = \frac{18{,}750}{375} = 50$ amperes; this checks with the values given. All these expressions are important and should be applied where possible to solving the study problems until the students have thoroughly familiarized themselves with them.

1. Find the joint resistance of a circuit having three resistances connected in parallel of 5, 8 and 12 ohms respectively. If the total current in the circuit is 50 amperes, find the current and watts in each of the three circuits, the total watts, electrical horsepower and volts.

2. An arc lamp takes 900 watts on a 120-volt circuit; find the current and resistance of the lamp.

3. A circuit consisting of five incandescent lamps connected in parallel takes 2025 watts, an ammeter in the circuit reads 15. Find the resistance of each lamp, the voltage across the circuit, the electrical horsepower required and the rating of each lamp in current and watts.

The Servant's Intoxication

By Chesla C. Sherlock

The subject of intoxication has caused the courts no end of trouble. Cases are daily brought before the bench and bar which involve the question of whether intoxication affects the ordinary rights which a person would enjoy if he were sober.

If a workman is injured while under the influence of liquor, can he plead intoxication as a defense to his own negligence? The law is well settled that an intoxicated person is required to exercise ordinary care for his own safety. Indeed, he must use the same degree of care that would have been exercised by an ordinary prudent (sober) man under similar circumstances.

One authority has held that "one cannot voluntarily place himself in a condition whereby he loses the control of his brain and muscles as a man of ordinary prudence and caution in the full possession of his faculties would exercise, and hold another, ignorant of his condition, liable for injuries to which such condition contributed."

Intoxication in itself will not operate to defeat a recovery. It is not of itself such a lapse of prudence as will amount to contributory negligence and defeat a recovery; nor is intoxication negligence per se. It is, however, a circumstance to be considered in determining contributory negligence. In other words, it is what is known at law as an evidentiary fact from which negligence may be inferred if the circumstances warrant it.

In some cases where the injured party was intoxicated, he has been denied a recovery, but such denial was not alone because of intoxication. Such condition must have caused the accident in order to defeat a recovery of damages, or have contributed to it. Where such intoxication does contribute to the injury through his failure to exercise the degree of care that one would expect an ordinarily prudent person to show under similar circumstances, he cannot recover.

One authority, after discussing the foregoing rule, goes on to say: "If the voluntary intoxication of a person leads him to place himself in an exposed position, or prevents the full use of his faculties, so that injury results therefrom, and but for such intoxication the injury would not have resulted, then such injured person is guilty of contributory negligence. The mere fact, however, that a person at the time he may receive an injury is intoxicated, is not of itself evidence of contributory negligence, but is a circumstance to be considered, and it is for the jury to determine whether it in fact contributed to his injury."

According to this conception of the law we find, then, that the negligence of a person is not dependent upon his physical or mental condition, so far as sobriety is concerned. It was so held in a given case that the mere fact that one who was injured while alighting from a train was intoxicated at the time was not per se contributory negligence. It has been held, however, that an intoxicated person who sits or lies down on a railroad track is guilty of contributory negligence and, if injured, cannot recover damages.

Injured While Trespassing

It seems to be the rule of law that when an intoxicated person is injured while trespassing, he cannot recover damages because he is guilty of contributory negligence. It is the opinion of a majority of the cases that the fact of voluntary intoxication and the trespassing are sufficient to amount to contributory negligence. Indeed, where any recovery has been allowed at all, it has been under the rule of comparative negligence. That is to say, the party causing the injury has been so grossly negligent that his fault overshadows that of the intoxicated person, and the intoxicated servant is allowed to recover the difference.

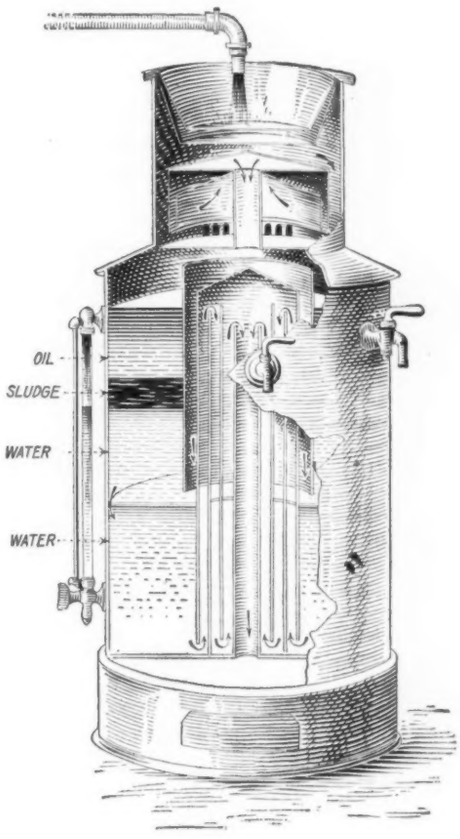
It has been held, in an action by an employee against his employer for injuries received because of the negligence of a fellow servant, that evidence of the negligent servant's habits as to intoxication are admissible against the employer. In one case evidence was admitted which tended to show that the negligent employee had been under the influence of liquor on an average of once every two weeks for twenty-five years and that the effect of such continued use of liquor on his system was such as naturally would cause him to commit the act in question. Such evidence, of course, tends to prove that if the employer had been vigilant he could have anticipated such accident and have prevented it by removing the cause, and failing in this, he was liable in damages to the injured servant.

It is well for employers to remember that intoxication in itself is not negligence, nor contributory negligence; but under ordinary circumstances only an evidentiary fact which will be taken into consideration along with other facts in determining the case.

Ten Winkle Oil Reclaimer

A device for saving waste oil and restoring its mineral constituent is being made by the Ten Winkle Oil Reclaiming Co., Chicago. The reclaimer operates by gravity, depending on screens and the reversal of flow through water to remove the heavier impurities and the passing of the foul oil through its own slimes to complete the purification.

Waste oil from separators or drips is introduced into the double strainer at the top of the device, passing through to a hood immersed in water up to the base of its conical top. The oil flows down around the sides of the hood, passes through openings in the bottom into the interior, then through a fine-mesh conical screen and the water to the overflow at the center. From the overflow the oil drops on a hood in the lower compartment and is guided downward between concentric cylinders to a horizontal diaphragm. Here the oil passes through openings at the bottom of the vertical division wall, spreads out on the diaphragm and rises through the water. Any addition to the water may pass down around the edge of the diaphragm through the series of seals to the overflow at the center.



SECTIONAL ELEVATION OF THE RECLAIMER

By the time the oil reaches the diaphragm, the foreign matter heavier than water has been separated. Those impurities lighter than water are caught in the film of slime that forms between the surface of the water and the purified oil above. Outlet cocks are provided to draw off the purified oil to reduce the quantity of slime when its collection exceeds the requirements. Provisions are also made for the removal of the heavier impurities from both upper and lower compartments.

Determining Pipe-Main Sizes

By Alfred Iddles

SYNOPSIS—A chart by the use of which the various sizes of a run of pipe, with risers taken off at intervals, can be easily determined and so proportioned that the velocity in each section will be approximately the same.

The task of determining correct sizes of pipe for steam-heating mains has been rather tedious when using the familiar tables found in handbooks. These tables are usually given for a certain length of pipe and a certain drop in pressure, neither of which may fit the given condition. The use of a chart such as is here given makes this calculation simple and quickly performed and accurate within ordinary limits.

Babcock's formula for the flow of steam in pipes has been used in computing the values and plotting the chart. Following is the formula and the modifications used to make it apply directly to heating problems:

$$W = 87\sqrt{\frac{cPd^5}{L\left(1+\frac{3.6}{d}\right)}}$$

in which

W = Weight of steam delivered per minute;
c = Density of steam at pressure used;
P = Drop in pressure between source and point of discharge, in pounds;
d = Actual inside diameter of pipe, in inches;
L = Length of pipe, in feet.

Assume one square foot of direct steam radiation condenses 0.25 lb. of steam per hour—a conservative estimate and one quite generally used. Then W, lb. steam per min. becomes $60W$ lb. per hr.

$$\frac{60W}{0.25} = 240W = R = \textit{sq.ft. of radiation}, \text{ or } W = \frac{R}{240}$$

Substitute this value for W in the formula. Assume the average pressure, for low-pressure steam heating, to be 18 lb. absolute, or 3.3 lb. gage. Then c = density of steam at 18 lb. absolute (from steam tables). The formula becomes

$$\frac{R}{240} = 87\sqrt{\frac{0.045Pd^5}{L\left(1+\frac{3.6}{d}\right)}}$$

The only variables then are P, d, L and R, all in terms that will be found in an actual heating problem.

On the chart nominal pipe diameters are marked on the pipe-size scale, while actual inside diameters were used in the calculations.

To use the chart, after the steam main has been located and the risers and all radiation to be fed by the main has been calculated, make a rough diagram of the main and load, similar to Fig. 1.

Starting at one end of the main mark on one side of the line the square feet of radiation for each riser, in the order that the risers leave the main. Then start at the end of the main farthest from the source of supply and add the square feet of radiation, marking each sum opposite the riser load and on the other side of the line.

Scale the total length of the main and allow for the fittings, etc., by additional lengths.

Determine the allowable drop in pressure throughout the whole main. This drop and the total length will remain constant for this main. The two variables are the diameter of the pipe and the radiation, and only the diameter is unknown.

Now referring to the chart, Fig. 2. From the point on scale marked drop in pressure, which corresponds to the assumed drop, draw a line to the point on the length scale which corresponds to the total length of main in question. Where this line crosses the vertical line marked A is a pole to be used throughout the consideration of this one main (L and P remain constant).

With a straight-edge always touching this pole, locate a line passing through the point on the radiation scale, which corresponds to the maximum radiation to be carried by the main (shown by the sum of all riser loads on the diagram, Fig. 1). Where the straight-edge crosses the scale marked "diameter of pipe" read the pipe size required. Start the main with this size pipe. Move the straight-edge, still touching the pole on line A, until it indicates the next smaller pipe size. Read the radiation indicated, and this determines the maximum radiation which will be supplied by this smaller pipe. Locate

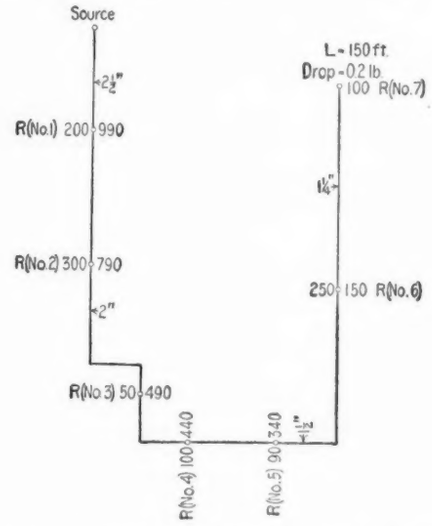


FIG. 1. GENERAL OUTLINE OF PIPE LAYOUT

on the diagram, Fig. 1, the riser with this radiation or nearest to it (not larger) and between this riser and the next riser nearer to the source, the size of main can be reduced. Proceed thus to the end of the main.

Each section of pipe thus determined will carry its load with a proportionate drop; so that the total drop in the main as a whole will be that assumed at the beginning.

Thus in a very few minutes the main sizes can be determined without making a single extended calculation.

The chart is also useful for proportioning riser sizes and the sizes of gravity return lines, etc.

Drawn for different assumptions of steam pressure and load a similar chart can be used for other kinds of steam flow problems.

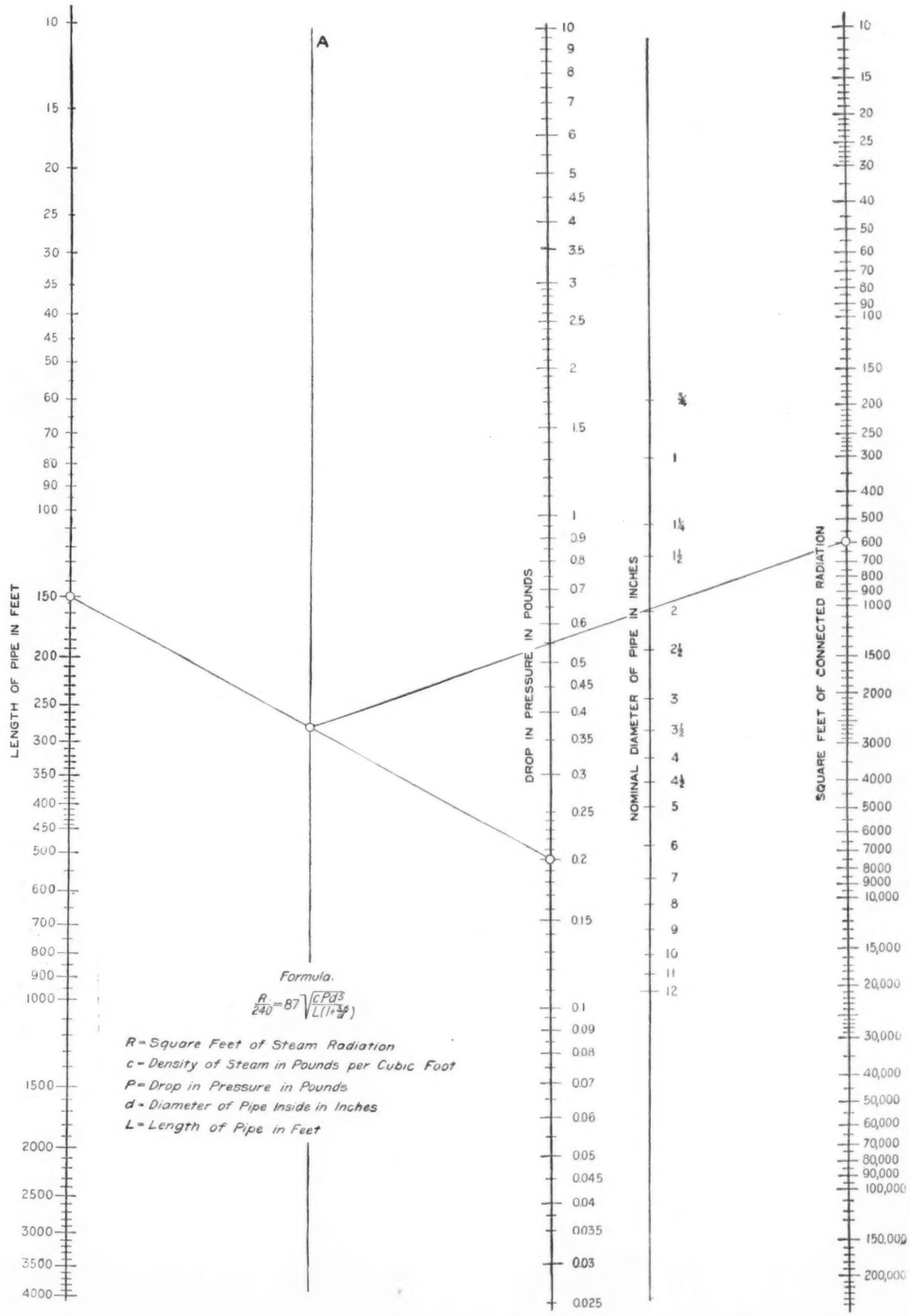

LENGTH OF PIPE IN FEET
A
DROP IN PRESSURE IN POUNDS
NOMINAL DIAMETER OF PIPE IN INCHES
SQUARE FEET OF CONNECTED RADIATION
Formula.
$\frac{R}{240}=87\sqrt{\frac{cPd^3}{L(1+\frac{3.6}{d})}}$
R = Square Feet of Steam Radiation
c = Density of Steam in Pounds per Cubic Foot
P = Drop in Pressure in Pounds
d = Diameter of Pipe Inside in Inches
L = Length of Pipe in Feet

FIG. 2. CHART FOR DETERMINING PIPE SIZES FOR GIVEN RADIATION UNDER VARIOUS CONDITIONS

Boiler-Room Signaling Systems

In large electric plants where the load fluctuates, there is usually some kind of a signaling system to indicate to the fireman what load is being carried in the engine or turbine room. Sometimes this signal is an arrangement in which lights are placed and in front of which are figures painted on glass. When illuminated, the figures show the fireman what load in kilowatts is on the machine at the time or is soon to be expected. In this way the firemen can efficiently carry their fires to take care of the load. This system is generally controlled by the switchboard operator.

An automatically operated system is described herewith, as found at the power plant of the Worcester & Blackstone Valley Railway Co., Worcester, Mass. In the boiler room is an indicating board, Fig. 2, on the front of which is a glass cover upon which are painted figures from 1 to 10. Back of each number is an incandescent lamp. These figures represent the steam

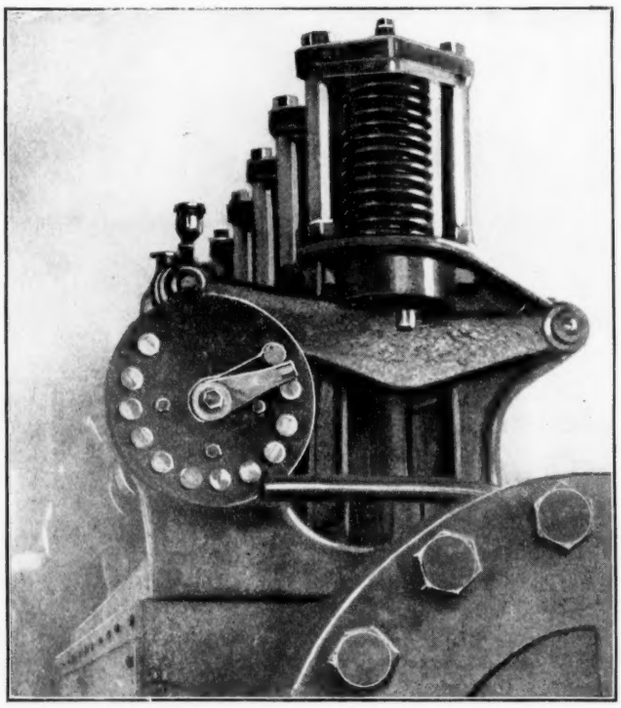


FIG. 1. CONTACTS ON VALVE CAMSHAFT

valves on the steam turbines. When one valve is open, the figure 1 is illuminated; if six valves are open, the figure 6 is illuminated, and so on up to 10, thus showing the fireman how many steam valves on the turbines are open.

This automatic illumination is produced by a home-made arrangement that is attached to the steam-valve camshaft of each turbine. At the end of the camshaft is a contact head in which ten contact pieces are secured and insulated. To the end of the camshaft a contact finger is attached, Fig. 1. The first contact head at the right is connected by a spring to the hub of the contact finger and it is also connected to one side of the 110-volt circuit. Each of the other contact heads is connected to one terminal of an incandescent lamp. The other lamp terminal connects with the other side of the 110-volt circuit. An idea of the wiring is given in Fig. 3. The contact fingers will move in the direction of the arrow.

Alongside the signal board in the boiler room is a gage notifying the fireman as to the depth of water in

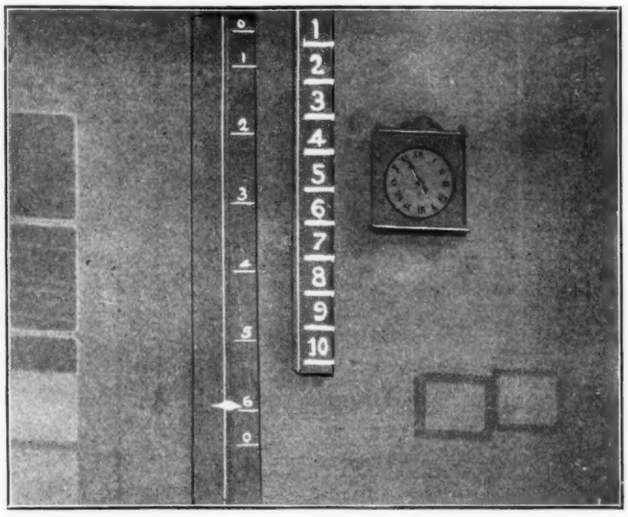


FIG. 2. TURBINE VALVE INDICATING SIGNAL AND HOTWELL INDICATOR

the hotwell. This arrangement consists merely of a float from which a cord is run over pulleys to an indicating pointer. When the pointer is at the top 0, Fig. 2, it indicates that the hotwell is empty. When it is at the bottom 0, it indicates that the well is overflowing and that hot water is being wasted. The intermediate figures show the depth of water in the well.

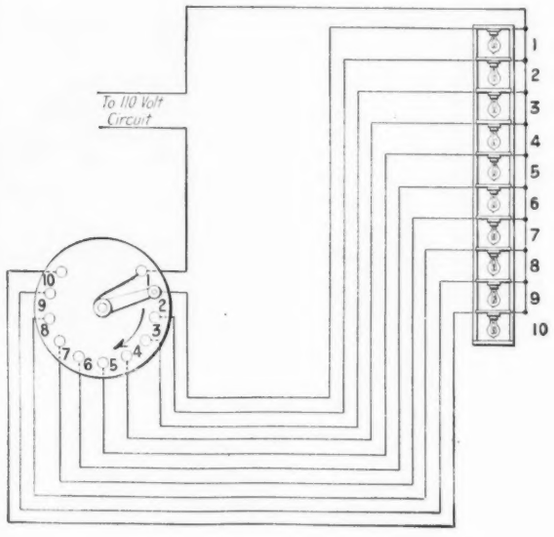


FIG. 3. DETAILS OF WIRING BETWEEN CONTACTS AND SIGNAL LAMPS

Although this is a simple arrangement, it is one that will prevent considerable hot-water waste if it is given attention.

Stationary Engineer As Expert Witness—A stationary engineer was qualified to testify as an expert witness whether a locomotive observed by him had shut off steam before it struck an automobile at a public crossing, where he had had experience, although 25 years before, in operating locomotives. (West Virginia Supreme Court of Appeals, Hunter's Administrator vs. Chesapeake & Ohio Railway Co., 91 Southeastern Reporter, 181).

Editorials

Per Cent. Regulation

The laxity with which engineering and scientific terms are used frequently causes misunderstandings, and in fact may lead to an opposite interpretation of what the writer or speaker intended to convey. Probably nowhere is this more prevalent than in reference to "per cent. regulation."

As applied to electrical machinery the term "regulation" generally refers to the decrease or increase in voltage from various loads to no load. That is, if at full load the voltage of a generator is two hundred and twenty and when the load is removed the volts increase to two hundred and twenty-five, the difference between the two values expressed as a percentage of the full-load volts is called the per cent. regulation. Operating the machine under various conditions will either improve or make the regulation worse; that is, the regulation range is within closer or wider limits, or the regulation may be said to be better or not so good. Any one of these expressions cannot be misconstrued to mean anything else than an improvement or its opposite. But on the other hand, when we say that the per cent. regulation has been increased or decreased, the chances are that the expressions will not be taken literally and will be misconstrued to mean the opposite; that is, an improvement in regulation when an "increase" is referred to and not so good when "decrease" is used. Taken literally, the term "increased" is correct, for if the per cent. regulation is increased, it indicates that the device regulates within wider limits, which means that the regulation is not so good. On the other hand, if we say by changing the design of a machine its capacity was increased, it will indicate that the machine, as far as capacity is concerned, has been improved. In this case the terms "increase" and "improve" are synonymous, and this is the general conception. But when applied to the regulation of a machine, the terms have an opposite meaning and to the average practical reader are confusing.

Since a large percentage of the readers of technical literature are more practical than literary and want the story in unmistakable terms, it is the duty of those whose task it is to supply the technical reading matter to exercise care and see that it is not only correct from a literary point of view, but also from the practical.

In the Other Fellow's Shoes

Mr. Manager: One of these hot summer days when, notwithstanding the cooling breezes from your open window and your desk fan and notwithstanding the absence of necessity for physical exertion, you are sweltering and uncomfortable, just drop down to the engine and boiler room and have a little chat with your engineer.

A little colored boy, who was kicking himself viciously, explained, when asked the reason, that he was doing it because it felt so good when he stopped. When you come up out of that basement, you will wonder how the office ever seemed hot to you.

And perhaps, with a realizing sense of your own discomfort and impaired efficiency under much less onerous conditions, you will wonder if it is really necessary that men the environment of whose daily life is in your hands should live under such enervating conditions. If it is not necessary, you would certainly not insist upon it. You know that they burn many dollars' worth of coal down there and think that it must necessarily be a hot and dirty place; but there are usually simple things that can be done to ameliorate the conditions. Connections to the ashpit that will draw off the heated air from the top of the room; a liberal supply of fresh air from outside, pushed in by a fan if necessary; a liberal use of nonconducting covering on heated surfaces—these will reduce the temperature many degrees, make you a better man to work for, give you a choice of better help and quite likely even save you money.

If you don't know what to do about it, just make an excuse for stopping at the engineer's desk on a good hot day, remark about his keeping it warm down there, and ask him why he does not do something to cool it off. If he is much of an engineer and you show him that you are ready to entertain it, he will soon come back with a practical suggestion.

Ontario Hydro-Electric Commission a Producer

Announcement that the Hydro-Electric Commission of Ontario has acquired the properties of the Ontario Power Co., the largest of the Niagara plants, carries deeper significance than the mere fact that a large power company has changed hands; for it reflects a growing tendency toward greater governmental participation in developing natural resources.

Created in a small way eleven years ago, the Commission has extended its activities until it now supplies one hundred and seventy-four towns, cities and villages, besides seven townships. This phenomenal growth has been in the face of strong opposition and criticism from the power companies, but with the backing of the people and the support of the Ottawa government. The commission may have made mistakes, but its purpose has been achieved; it has been the means of distributing cheap power throughout the province of Ontario and bringing it within reach of the rural districts, thus opening up to development sections that would have otherwise waited long for the opportunity.

Heretofore principally a distributing agency, the commission now takes up the task of producer. It is noteworthy that the acquisition of the Ontario Power Co. was not a cash transaction; and the people of the province are therefore not called upon through taxation to contribute a cent toward the purchase. Instead, payment was made in debentures of the commission and

in the assumption of liability for outstanding bonds. The debt will be met out of current receipts, and it is estimated that the plant will pay for itself within the next twenty-five years.

When the present plans of the commission, which include the Chippawa Creek-Queenstown Heights development, are completed, it will be the largest producer of hydro-electric power in the world. The work is going on in spite of the war, and it is believed that when conditions have again become normal, this section of Canada will have made great strides in industrial development.

The work of the Ontario Hydro-Electric Commission for the next few years will be watched closely from across the international boundary, and the results are likely to be reflected in this country. For the last six or seven years the water-power interests and Congress have been deadlocked over a water-power policy; meanwhile development has been at a standstill. The old way of doing things has passed, and unless the contending factions reach some equitable agreement, the people are likely to step in and adopt some system perhaps modeled after the Canadian idea.

Figuring Pump Sizes

Engineers of limited experience with things hydraulic often complain that much of the literature available in the way of handbooks and trade catalogs offers little definite aid in solving practical problems such as figuring the size of a pump needed for some special purpose—boiler feeding, elevator service, or the like. Such complaints are apparently not without cause. There does seem to be a want of definite direction. There is the rule, for example, that first marks out the course to be followed in determining the cylinder dimensions corresponding to the volume of water it is designed to deliver with an assumed velocity of piston travel, and that closes with the supplementary advice to "add from ten to fifty per cent. for leakage, slip, etc."

It is this qualifying clause that generally leaves the seeker for information in doubt as to exactly what he needs. In making allowance for the losses mentioned, he is given free choice in a range of values from one-tenth to one-half of the actual volume of water to be delivered per stroke. Shall it be the minimum or the maximum rate given or some intermediate value? What is there to definitely decide this point?

Also what is to be taken as the actual meaning of the figures given in the tables of pumping capacities based on a piston speed of one hundred feet per minute? Are the cylinder dimensions set down in these tables to be regarded as corresponding to the volume of water theoretically displaced with the piston traveling at the velocity assumed, or has friction leakage and slip been taken into account when fixing these dimensions, and if so have the theoretical values been increased ten, fifty or some other percentage? Then there are still to be accounted for the items vaguely covered by that inevitable "etc." What are these etceteras? The average well-posted engineer would be stumped offhand to think of any other extras that should enter into the reckoning beyond those already mentioned—leakage, slip and friction. It is probable that this is a subject regarding which compilers prefer to adopt a broad, comfortable mode of statement rather than a narrow and precise definition of the course which the inquirer should pursue; and this because suggestions offered on a foundation so ample are bound to be stable enough to withstand criticism on the score of inaccuracy. While such practice may comfort the authors of this kind of literature, it offers scant solace to the man who wants to know what to do in a particular case; who wants to be directed straight to the mark instead of being left to ramble through a latitude of doubt.

A safe plan for an engineer to follow in selecting a pump for any ordinary work about the plant would be first to find out what a quantity of water it will be necessary to move under the most rigorous conditions of the service that are to be provided for, and then to so proportion the stroke and diameter of his pump that its theoretical displacement will equal this volume when the piston is moving, say, thirty strokes per minute. Unless the pump required would be uncommonly large, as one having a stroke much in excess of twenty-four inches, this method of figuring would bring him well within the assumed limit of one hundred feet of piston speed per minute and would relieve him of all extra bother in the matter of providing against leakage and slip and the etceteras implied in the proffered rules.

The sound engineering principles governing the decision of the California State Railway Commission in approving the consolidation of the Southern California Edison Company and the Pacific Light and Power Corporation, published elsewhere in this issue, was clearly set forth in the conditions outlined by the commission, in which it says in part: "The Pacific Light and Power Corporation has a large hydro-electric development which is not and will not in the near future be put into full use unless the consolidation occurs. On the other hand, the Southern California Edison Company is using to capacity its hydro-electric installation and, unless this consolidation occurs, will be confronted with the almost immediate necessity of increasing its production of electric power. Therefore, the considerable surplus of power now possible of generation in the plant of the former will be brought into use in the latter, which will provide for a considerable expansion of business of the consolidation without the necessity for large expenditures in increasing production capacity." Taking advantage of such conditions, is not only a war-time necessity, but should prove of great economical advantage in times of peace.

Professor Charles R. Cross, of the Massachusetts Institute of Technology, is retired after forty-seven years of active work, chiefly in physics and in electricity. Professor Cross has for many years been a leading figure of the Institute, and as a consulting physicist has been much in demand. To him, perhaps more than to any other man, belongs the credit for first establishing technical study in electrical engineering. He was one of the first to insist on instructing his students in electrical study. Also he deserves much credit for his pioneer work in the department of electrochemistry and industrial physics. It is for the fundamental development in these branches of education that Professor Cross will be remembered in the engineering educational world, although he interested himself in the development of the telephone and in other branches of physics.

Correspondence

Steam-Engine Troubles—Operation

The article by H. Hamkens in the May 1 issue is well worth the study of every engineer who reads *Power*. There are, however, several statements on which the writer desires to comment.

Mr. Hamkens writes: "If the oil supply is liberal, as it will be if a continuous oiling system is installed, oil grooves in connecting-rod boxes are superfluous; but where the oiling is done by the drop feeding from oil cups, grooves will improve the distribution of the oil."

Experience has taught me that oil grooves are necessary to insure an adequate distribution of the lubricant when either one of the oiling systems referred to is used, unless the boxes are run quite slack and dependence is placed upon the body of oil between the pin and box to produce a quiet running engine. However, I believe this method is a questionable one and that the better way is to provide sufficient grooves to distribute the oil freely to all parts of the bearing, which will make it possible to key up close enough to produce a quiet running engine.

Mr. Hamkens also states that the crosshead pin boxes should be grooved only on the top, or upper side. I believe that this statement is wrong, for the oscillations of the crosshead boxes tend to keep the oil at the top of the pin, and as the greatest friction is at or near the center of the boxes, the grooves should be located there.

Further, he writes: "The shells and quarter-boxes of the main and outer bearings should be examined after the engine has been run several days, and if they show unequal wear they must be lightly scraped." To my mind this is bad practice, for as a rule, the erecting man has correctly aligned his engine and fitted the main and outer bearings by spotting them and scraping down the high points until the bearings are as near a perfect fit as this method will produce. After the engine has been run for several days, there will certainly be found uneven wear if the shells and quarter-boxes of these bearings are removed, and if rescraping is done to secure an equal bearing, this procedure can be continued throughout the life of the engine and the bearing will not be a true running fit. When a bearing has once been properly aligned and fitted, let it alone unless excess heating indicates trouble, for the running fit is the most perfect that can be produced. Then, too, the labor and expense of lifting a large shaft with its attachments, simply to examine the bottom shell when no trouble is indicated, is an item to be considered. Will Mr. Hamkens please explain why reliable engine builders cut liberal oil grooves in the lower shells and quarter-boxes if there is no need of them?

Again quoting Mr. Hamkens: "It is dangerous to throw water over or 'turn the hose on' the connecting-rod and boxes if the crosshead pin or crankpin gets hot; they will contract if suddenly cooled and close in on the pins, pinching them that much tighter, which may result in a serious breakdown." This may be correct if the containing ends of the connecting-rod could be cooled separately; however, as this cannot be done—at least not in general practice—I fail to understand how the cooling process referred to will cause the boxes to close in on the pins. In the first place the overheating causes excessive expansion of the parts under consideration and may, with bronze boxes without babbitt lining, be carried to a point where the boxes will grip the pin with sufficient force to slacken the speed of the engine and in some cases stop it. Should one then "turn the hose on" while the engine is running, the water comes in contact with the crosshead pin or crankpin, as the case may be, as well as with the connecting-rod ends. This contracts the metal in the two parts mentioned, and the action is rapid enough to more than compensate for the reduction of the opening in the connecting-rod ends. Instead of the boxes closing in on the pins, they relieve the pressure on the pins sufficiently in many cases to permit the engine to finish out the run. While I do not advocate the use of water on hot boxes, in cases of necessity I have used it and kept the engine in operation and no bad results followed.

A. K. VRADENBURGH.

Albany, N. Y.

Operating Mechanical Stokers

The article dealing with the operation of chain-grate stokers, page 618 of the May 15 issue of *Power*, is interesting and instructive. We are operating two chain-grate stokers, and some points which are not touched in the article and which we have learned during a period of two years' operation may be helpful.

We have found a grate speed of 2½ in. per min. to be ample for our fuel, which is bituminous slack and anthracite screenings mixed equal parts, as against the average of 3½ in. per min. as given in the article. As stated, various classes of coal require different handling, and we have found that the grate speed has to be varied with the ash content of the coal; a faster grate for high-ash and a slower one for low-ash content. A slow grate for a high-ash content produces too thick an ash bed and causes a bank of ash and clinker to form at the water-back. A fast grate carries the ash away faster.

The chain speed should also be varied for a difference in the fixed-carbon content; for instance, an 85 per cent. fixed-carbon coal requires a slower grate than one having a 65 per cent. fixed-carbon content, the thickness of fire to be the same in both cases.

When we first began operating these stokers, we were troubled with banks accumulating at the water-back caused by too heavy feeding for a short period, the problem being to get rid of the bank after it had formed.

We finally discovered that we can nearly always burn the bank out without much trouble by stopping the feed for a few moments and allowing the grate to move until the fire is drawn out very thin just at the edge of the coking plate, where the coal drops onto the grate, after

which the feed is again started. This results in a strip of thin fire the entire width of the grate, through which a large part of the air passes, resulting in rapid combustion. As the grate moves, this narrow strip is carried backward and the coal at the top of the bank falls onto it and is burned. We find this method much easier and more efficient than raking and pushing the bank down.

Clinker formation at the front of stokers, causing stoppage of coal feed in the corners, which resulted in the making of air holes, has been eliminated in our installation by putting in water-cooled ledge plates.

Ithaca, N. Y. C. B. HUDSON.

In the article on operating mechanical stokers, page 692, May 22 issue, it is stated that the average cost per rated boiler horsepower for underfeed stokers with horizontal retorts is about $4.50. So far as the actual stoker is concerned, this is not so far off, but it seems to us that to be of any value this figure would necessarily include engine, blower, regulating valve, automatic control, etc., all of which are a part, and a very necessary one, of the stoker equipment. If these are included, the price per rated horsepower would be nearer $7 than $4.50.

The maintenance cost for underfeed stokers of 4c. to 6c. per ton of coal burned is much higher than the maintenance cost of Jones stokers. We do not know of any plant where the equipment is given any attention, in which the maintenance cost would reach the figures mentioned in the article. H. F. POST.

The Under-Feed Stoker Co. of America.

Chicago, Ill.

[A folder relating to cost repairs of Jones stokers per boiler horsepower equipped gives a list of 319 stokers that have been installed to serve 53,915 boiler horsepower. The average length of service per stoker in years is given as 5.93, and the average repair cost per year per horsepower at rating is $0.0357.—Editor.]

Steamboat Throttle Failed from Water Hammer

The throttle valve of the starboard engine on the Government boat "Nokomis," at St. Louis, was exploded by water-hammer on the afternoon of Apr. 28, and five members of the engine crew were seriously scalded by the rush of escaping steam. The boat is used for experimental purposes—boiler and engine tests and the like. There is a battery of 40-in. by 30-ft. flue boilers set forward on the main deck in the usual manner, connected to a lateral drum from which the 8-in. main steam pipe runs aft and branches overhead to the two engines coupled directly to the paddlewheel in the stern. The accident was caused primarily by an oversight when coupling up the main pipe, for instead of the pipe having the usual sharp inclination toward the boilers to drain the water of condensation back to the boilers, the contrary was the case; the pipe sloped about six inches toward the stern, so that during the several hours after steam was raised to the working pressure of 160 lb., before everything was ready for the run, considerable water accumulated in the pocket thus formed. The engineer, unaware of the presence of water in the main pipe, gave the throttle wheel a turn, and almost instantly the valve ruptured under the impact of the slug of water.

The body of the valve was designed to be about 1 in. thick, but the core had been shifted to one side in the mold, so that the shell was only $\frac{9}{16}$ in. on the thin side.

St. Louis, Mo. A. J. DIXON.

Bleeding Turbines and Engines

My attention has been called to an article in the issue of May 15, page 652, entitled "Bleeding Turbines to Heat Feed Water," and in connection with this article your editorial (page 667) correctly points out that this is an approximation to the Carnot cycle. Using multiple feed-water heaters served by steam tapped out at successive stages of expansion in the prime mover was invented by B. V. Nordberg, who was the designer of the Wildwood pump referred to in your editorial and to whom full credit should be given.

Recognizing the feasibility and high economy of this method in 1900, when chief engineer of the Champion Copper Co., I installed the high-duty air compressor, described in a paper by O. P. Hood in the "Transactions of the American Society of Mechanical Engineers," 1907. This engine showed a thermal efficiency of 25½ per cent., which is still, I believe, the highest thermal efficiency attained by any steam engine, although the conditions of test were not the most favorable because the steam was very wet and the pressure 243 lb., while the engine was designed for 300 lb. This engine has been in successful and continuous service for 12 years, and it occurred to me that the foregoing facts might be of interest.

New York City. F. W. O'NEIL.

DETAILS OF THE TEST, BY HOOD, REFFERED TO ABOVE

A test of this quadruple-expansion air compressor (at the Champion Copper Mine) after the machine had been in commission 17 months, when in good working order but without special changes or adjustments, showed a performance of 194,930,000 ft.-lb. of work per million B.t.u. supplied to the engine, and established a world's record for efficient steam-engine performance. It exceeded the performance of the Wildwood pumping engine by 9 per cent.

The efficiencies were as follows: Efficiency of Carnot cycle between temperature of incoming steam and temperature corresponding to pressure in the condenser, 34 per cent.; actual heat efficiency attained by this engine, 25.05 per cent.; relative efficiency compared with Carnot cycle, 73.69 per cent.; relative efficiency compared with Rankine cycle, 88.2 per cent. The 88 per cent. efficiency ratio compared to the Rankine far exceeds any other performance known. Large turbines show only 65 to 75 per cent. of the Rankine-cycle efficiency.

The engine was quadruple-expansion, 14½, 22, 38 and 54 x 48. The high-pressure cylinder was fitted with poppet valves, the other cylinders had Corliss valves. The initial steam pressure was 200 to 250 lb.

Between the cylinders were placed reheating receivers, "each supplying steam to the cylinder, the jacket and head, and the body of the next succeeding cylinder." "Each head of the low-pressure cylinder is provided with a rotating disk valve driven from the main shaft, the function of which is to abstract steam during expansion."

"The feed-heating system connected with the engine is divided into five approximately uniform steps with the object of gradually adding heat to the feed water by steam of progressively higher temperature which has done some work. An automatic float valve admits the feed to the preheater, where it gains in weight and temperature by contact with the exhaust from the low-pressure cylinder. The feed is raised by a pump to an elevated heater, where it meets steam drawn during expansion through a special valve from the low-pressure cylinder. By gravity the feed falls to a heater receiving the discharge from the low-pressure jacket line which came from the third receiver. A second pump transfers the feed to a heater receiving the second intermediate jacket water and the discharge from the trap on the reheater line. Pumped again to the last heater, the feed meets steam drawn through the first intermediate jacket from the first receiver. A fourth pump drawing from the last heater returns the feed, augmented in pressure, weight and temperature through an economizer to the boilers."

The temperatures of the feed water during its progress through the cycle were as follows: Water to preheater, 92.6 deg.; to heater No. 1, 114.3 deg.; to heater No. 2, 173.1 deg.; to heater No. 3, 202 deg.; to heater No. 4, 269.7 deg.; from No. 4, 334.5 deg.

This engine was started up about twelve years ago and has been in constant operation since that time. It is the only compressor at the mine of sufficient size to supply the drills, and is shut down only on Sundays. There have been hardly any repairs on the engine and none whatever on the heating system. They have not even cleaned out the heaters, and when Mr. Nordberg was at the mine some two years ago, he was asked how the heaters were constructed, some of the men who had not seen inside of them having an idea that they were tubular or surface heaters, whereas they are open-pan heaters with steam and water in direct contact.

The high-pressure cylinder was rebored a few years ago, also some of the compressor cylinders. This was done with steam in the high-pressure jacket and in the steam chest, steam being turned on with the poppet valves tripped. The valves had never been ground in and were tight enough, so that the cylinder could be rebored with steam pressure in the chest. This, it may be remarked in passing, is an excellent test of the steam-tightness of this type of poppet valves. From the trend of the discussion to Professor Hood's paper, one would have supposed that this engine would have had a very short life and that subsequent events would have proved not only its mechanical shortcomings, but others of a thermodynamic nature. The fact that this remarkable engine is still running at what is believed to be even higher efficiency than that shown by the test on account of steam of better quality, and that its operation gives so little trouble, are matters which should be put on record.

As the writer stated in these columns some time ago, the mistake is commonly made when considering the use of exhaust steam from auxiliaries for heating the feed water, of crediting the heat saving entirely to the power developed by the auxiliaries. In this way such figures as the 80 per cent. mentioned are obtained. The saving by heating the feed water should properly be credited to all the power generated in the plant, going thus to raise the over-all thermal efficiency. Heating the feed water in successive small steps up close to the boiler temperature by this regenerative system therefore leads to more efficient operation of the entire plant than heating it in only one step to 210 deg. in an open heater served by atmospheric exhaust from auxiliaries.

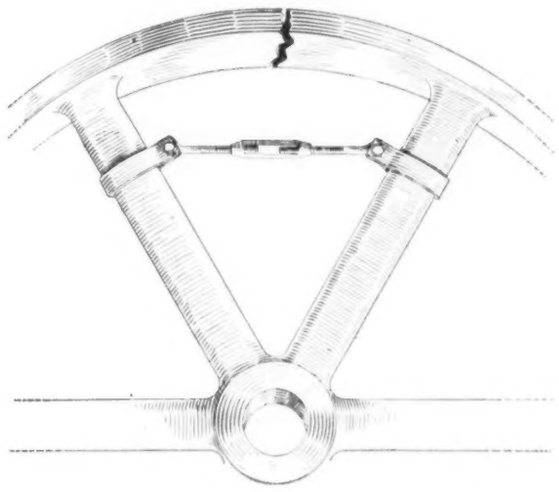
Professor Hood's statement that the feed-water heating principle involved "would seem to be especially easy to apply to turbine engines" is beginning to meet with more general recognition.

P. A BANCEL.

New York City.

An Emergency Pulley Repair

In the Apr. 24 issue of *Power*, page 573, is a contribution from M. A. Sailer, relating to an emergency pulley repair job, that has caused some little discussion at our place. A better way would be to place the clamp



PROPOSED METHOD OF PLACING CLAMPS

directly across the spoke, as shown in the accompanying illustration. It would then bind, as the pull exerted by the turnbuckle would be diagonally on the spokes, and hence the clamp would be clamped at two opposite points.

H. P. MOELLER.

New York City.

Heat from Excessive Oil

On page 707 in the issue of May 22, Mr. Sheldon in the telescopic-oiler discussion notes an effect for which he cannot locate a cause, and I have noticed this same effect and have reasoned out, at least to my own satisfaction, why the eccentrics run cooler with one drop of oil per revolution than with a full stream.

In my case this heating with a copious supply of oil takes place on a crosshead. The shoes are 9 x 12 in. bearing surface each and make 150 eighteen-inch strokes per minute. The engine runs "over," and the upper shoe is adjusted so that a piece of writing paper can be slipped in between it and the top guide at any time. That direction of rotation and adjustment of the shoe means that the shoe and guide do not actually rub, in operation, yet when fed a stream of oil instead of an occasional drop, they run so warm that the hand can scarcely be held on the top of the top guide at the end farthest from the cylinder. The "why" of it lies in

the fact that every molecule of a thin body of oil is being violently rubbed against its neighbor molecule, converting mechanical work into heat. Professor Joule determined the mechanical equivalent of heat by this very method of agitation. He placed 1 pound of water in a vessel and submerged in it a paddlewheel driven by a falling weight. He found that when (approximately) 778 lb. had fallen one foot the temperature of the pound of water had raised one deg. F. due to the agitation.

Eccentrics are generally run slightly slack, which means that only half the bearing surfaces are in contact at one time. A large supply of oil keeps this thin cavity full and the extra heat is generated. R. MANLY ORR.

Vancouver, B. C., Canada.

Power Factor Changed

On the old compound-wound types of alternators, a certain constant amount of field excitation is supplied by a separate exciter. The part of the excitation which varies with the load and by means of which constant terminal potential is maintained under variable conditions of load, is obtained by converting part or all of the alternating current into continuous current by means of a rectifier or commutator that is mounted on the armature shaft, as shown in the figure. The rectified current is passed through a series-field winding that is wound on the same polepieces as are the separately excited turns. The commutator has as many bars as the machine has poles, and alternate bars are connected together. Thus it will be seen that the brushes, if properly set, will have presented to them, and in synchronism with the current alterna-

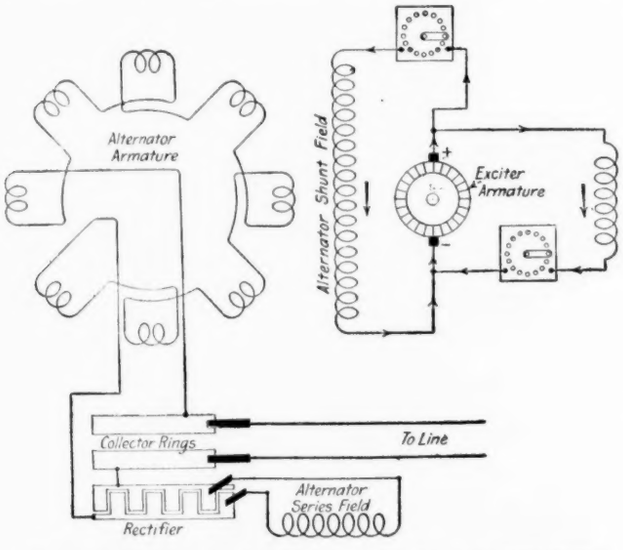


DIAGRAM OF INTERNAL CIRCUITS OF A COMPOUND-WOUND ALTERNATOR

tions, new pairs of bars. In order that there may be minimum sparking when the brushes pass the insulation between the bars, the brushes must be so set, by trial, that they traverse the insulation at the instant that the alternating current is passing through its zero value.

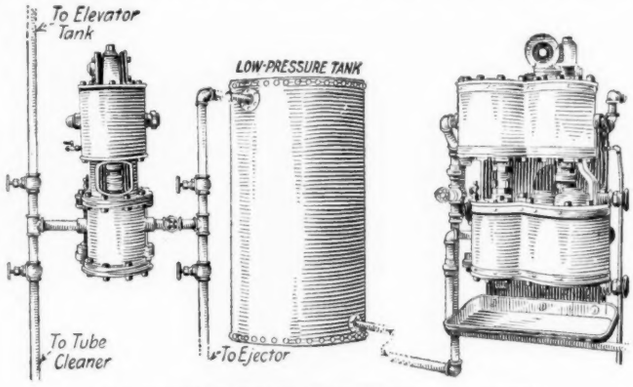
An operator of one of these machines complained that twice during each day it had become necessary to shift the rectifier brushes in order to get sparkless operation. As the machine had run for several years without such a shift being necessary, he thought that trouble might be developing in the machine.

Investigation disclosed that the periods of unsatisfactory commutation corresponded with the periods of operation of an induction motor that had recently been installed and that was operating with comparatively little load. Operating the motor at light load and low power factor changed the power factor of the circuit, causing the current to lag so that the zero point of the wave did not occur at the same instant that it did on noninductive load. Of course one position of the brushes could not satisfy both conditions. E. C. PARHAM.

Brooklyn, N. Y.

Air for Turbine-Tube Cleaner

On preparing to clean our water-tube boilers we were "up against it" for a suitable air-storage tank to run the air-driven tube cleaner at about 100 lb. pressure. We have one compound low-pressure (for ash ejectors) and one simple high-pressure compressor (for charging the elevator tank), both of the Westinghouse locomotive type, but only one tank and that is for the low-pressure air. The two compressors are so located that it would take at least 250 ft. of pipe to connect them so as to use the tank



AIR COMPRESSORS CONNECTED TANDEM

for the high-pressure air. We finally connected the suction of the high-pressure pump to the low-pressure tank and from its discharge line (to the elevator tank) ran a line to the tube cleaner, as shown in the illustration. This allowed the elevator tank to act as a storage and cushion. This arrangement has given perfect satisfaction and makes it possible to operate the ash ejector, the tube cleaner and pump into the elevator tanks at the same time. RALPH J. DALTON.

New York City.

Improvised Air Compressor

Quite a novel stunt was performed by one of our operating force to obtain compressed air during the time that our compressor was shut down for repairs.

One of the idle boilers was emptied and an air hose connected from the air cock on top of the boiler to the compressed-air tanks. The empty boiler was then filled with water, and as the water rose, the air was compressed and forced into the tanks. By closing the valves at the proper time and repeating the process, the receivers were charged up to 150 lb. and easily replenished. While this is not a new stunt, I have not seen it discussed in the trade papers. C. H. WILLEY.

Concord, N. H.

Inquiries of General Interest

Ratio of Suction-Valve Area to Plunger Area—What determines the area of suction valves for a duplex pump? L. B.

The ratio of valve area to plunger area usually is based on a water velocity through the valve seat of about 222 ft. per min. and a piston speed of 100 ft. per min., thus giving a valve area of 45 per cent. of the plunger area; though in careful designing, especially for large pumps, the tendency is to provide valve area 50 to 60 per cent. of the plunger area.

Advantages of Corliss Valve-Gear—What are the advantages of the Corliss valve-gear? W. L. R.

The leading advantages are: Short direct steam passages, reducing steam clearance; minimum power to actuate the gear; reduced valve travel, each valve being designed to move only a little after the port is closed and then remain at rest until time to open again; large and quick opening of ports for admission of live steam; instantaneous cutoff, free exhaust and adaptability to close governing.

Reduction of Thick Plates at Circumferential Joints—Under what conditions are the plates of a boiler reduced in thickness at the riveted joints? W. R. T.

Where the shell plates of horizontal return-tubular boilers are more than $\frac{9}{16}$ in. thick, the plates at the portions of the laps of the girth joints, where exposed to the fire or products of combustion, should be milled down to $\frac{1}{2}$ in. thick, to prevent burning of the plates at the laps, provided the necessary strength of the girth seam is retained.

Insufficient Condensation Head for Lubricator—We are having trouble to operate small cylinder lubricators on two oil pumps that are supplied from one $\frac{1}{2}$-in. line about 25 ft. long. The lubricators will not operate on condensation head made with $\frac{1}{4}$-in. pipe 18 in. long, tapped into the steam line? T. L. H.

The small lubricators undoubtedly would operate more positively by increasing the height of the condensation head. This could easily be obtained either by connecting the condensing pipe at least 3 ft. higher up on the line or by extending the present connection out of the lubricator that much higher and returning by a loop to the present point of connection with the steam line.

In Ordinary Pumps Steam Follows Full Stroke—At what point of the stroke does cutoff take place in a duplex steam pump? M. C.

The term "cutoff" generally is used with reference to shutting off the supply of steam when some fractional part of the stroke of a steam-driven piston has been completed. When the supply is maintained during the whole stroke, the steam is said to "follow full stroke." In an ordinary steam pump, the valve-gear causes the steam to follow full stroke so that the pump may be started from any point of the stroke and also because the inertia of the moving parts cannot be depended upon as sufficient assistance to the reduced pressure, during expansion after cutoff, to carry the piston to the end of the stroke.

Speeds of Induction Motors—At how many synchronous speeds can 60-cycle and 25-cycle induction motors be operated? L. F.

Theoretically, the number of synchronous speeds that can be obtained from 60-cycle and 25-cycle induction motors is unlimited. The synchronous speed of such machines is a quantity determined by the formula,

$$\text{Synchronous speed} = \frac{120 \times \text{frequency}}{\text{poles}}$$

From this formula it is evident that the maximum speed will be obtained for a two-pole machine. For a 60-cycle motor this speed will be 3600 r.p.m. and for a 25-cycle machine 1500 r.p.m. As the number of poles is increased the speed will decrease. However, because of mechanical limitations the number of poles cannot be increased indefinitely.

Inside and Outside Ferrules for Boiler Tubes—What are the relative uses of inside and outside ferrules on the ends of boiler tubes? W. R.

Where the joint between the tube end and the flue sheet is likely to leak on account of movement of the tube in the tube-sheet hole from expansion, an outside ferrule of soft brass or copper lightly rolled in the tube sheet and the tube afterward inserted and rolled inside of the ferrule will improve the permanency of a tight joint. Where the tube is weak or thin and is likely to spring back from the tube hole, strong ferrules of hard brass or steel are set inside of the tube ends. The durability of the joint is thus increased, and when the ferrules are flanged or beaded over, the tube ends are protected from the direct action of the fire.

General Formula for Delivery of Pump—What is the derivation of the formula, $g = \frac{D^2 \times L \times N}{294}$, for determining the gallons delivered per minute by a pump, and how would it be applied for determining the delivery of a duplex pump? R. O. J.

In the formula quoted,

g = Gallons pumped per min.;
D = Diameter of plunger or piston in inches;
L = Length of stroke in inches;
N = Number of single strokes per minute;

and the reduction of capacity due to piston rod and slippage are both neglected.

The complete general formula, based on a plunger displacement of 231 cu.in. per gal. and without allowances for piston rod or slippage, would be

$$g = \frac{0.7854\ D^2 \times L \times N}{231}$$

Dividing both numerator and denominator of the second member of the equation by 0.7854, the formula becomes

$$g = \frac{D^2 \times L \times N}{294.11}, \text{ or about } \frac{D^2 \times L \times N}{294}, \text{ as quoted.}$$

For a duplex double-acting pump, if N represents the number of revolutions, instead of single strokes, per minute, the formula for gallons pumped per minute becomes

$$g = \frac{D^2 \times L \times N}{294} \times 4$$

as there would be 4 single strokes per revolution.

Water Discharged in Blowing Down a Boiler—If a horizontal return-tubular boiler 72 in. diameter by 18 ft. long, that is filled with water within 16 in. of the top, is blown down 4 in. without uncovering any tubes, how many gallons of water would be discharged? H. H.

The area of a circular segment is given by the formula

$$A = \frac{4H^2}{3}\sqrt{\frac{D}{H} - 0.608}$$

in which

A = Area of segment in square inches;
H = Height of segment in inches;
D = Diameter of the circle in inches.

Hence the cross-sectional area of the steam space, when the water level is 16 in. from the top of the boiler, would be

$$\frac{4 \times (16 \times 16)}{3}\sqrt{\frac{72}{16} - 0.608} = 673.4 \text{ sq.in.}$$

and when the water level is 4 in. lower, the cross-sectional area would be

$$\frac{4 \times (20 \times 20)}{3}\sqrt{\frac{72}{20} - 0.608} = 922.1 \text{ sq.in.}$$

The difference, 922.1 — 673.4 = 248.7 sq.in., or 1.727 sq.ft., would be the cross-sectional area of the water that would be replaced by steam, and as the length of the boiler is 18 ft., the reduction in volume of water contained by the boiler would be 1.727 × 18 = 31.086 cu.ft. But the actual volume of water discharged would be somewhat less, as part of the original water would be required for conversion into steam to fill the space vacated by the water. Steam, at 80 lb. boiler pressure, or about 95 lb. per sq.in. absolute, has a density of 0.2151 lb. per cu.ft., and it may be considered that 31.086 × 0.2151 = 6.7 lb. of water would be thus retained. At 80 lb. boiler pressure the temperature of the water would be 324 deg. F. and 1 cu.ft. of the water would weigh about 56.5 lb., so that the actual volume of water discharged by blowing down would be, 31.086 — (6.7 ÷ 56.5) = 30.968 cu.ft., or 30.968 × 7.48 = 231.64 gallons.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Treatment of Hydrocarbon Fuels*

By H. G. Chatain

SYNOPSIS—The various processes are defined to which hydrocarbon oil is submitted to convert it into a readily explosive mixture. The problem is reviewed as it presents itself to the investigator today, and constructive suggestions and criticisms are offered that may assist in the development of the art.

After many other types of carburetors had been tried and failed, during several years of the early development of the liquid-fuel engine, the jet carburetor was brought out. This device had for its basic principle of operation the issuing of one or more small streams of gasoline into a rapidly moving mass of air. The inertia of gasoline in conjunction with the moving body of air possessed sufficient force so that the liquid was, strictly speaking, mechanically broken up and turned from a liquid into what might be termed a fog.

The design of this apparently simple piece of apparatus is indeed very complicated—so much so that in over twenty years with innumerable intelligent investigators working on the problem, it is still, although practical, far from being a comparatively perfect piece of apparatus.

It is well known that the gas formed by the mixture of air and gasoline fog is as highly explosive as possible when it is composed of 15 parts of air to 1 part of gasoline. This is proportioned by weight at atmospheric pressure. Above or below this figure the carburetion is not so good. Explosion, it is true, may occur, but its effect becomes mediocre, and obviously the power of the engine falls off. The disproportionate mixture may be carried to such a point that explosion does not occur at all.

RATIO VARIES WITH THE COMBUSTIBLE USED

It is well known that the ratio 15 to 1 varies with the combustible used. For example, it is necessary to have 15 parts of air to 1 of gasoline, but only 9 parts of air to 1 part of ethyl alcohol, 7 parts of air to 1 part of methyl alcohol, and so on for the various fuels. Therefore, if the carburetion of the air by the fuel is to be as good as possible, it is necessary that the proportions mentioned be kept constant through the range of speed, load and combinations of the motor. The changes in speed and in load produce a radical varying effect upon the carburetor, as the varying amount of air aspirated decreases or increases the depression or drop in pressure at the gasoline jet. Compensating for this varying depression has never been solved in an entirely satisfactory manner.

The first question that has confronted the constructor has always been this curious feature of the carburetor; that is, to find a practical mean between gasoline and air at various speeds, loads and combinations. The operator cannot be asked to make running adjustments by hand, therefore it is necessary, first, to find a means to make permanent the proper ratio and, second, to charge the motor with keeping this permanency of mixture.

It was at first thought that this ratio of 15 to 1 would necessarily stay constant, even with the variations in the functioning of the motor, and that the relative value of the depression caused by the aspiration of the motor would remain constant with relation to the gasoline and keep the proper proportions, the orifices admitting the air and gasoline to remain fixed.

This assumption was an error. Air is a gas and gasoline is a liquid; therefore the masses of the two bodies are not equal, and consequently the inertia of each is unequal. After the liquid is put in motion by the depression in the intake pipe, it has an inertia greater than that of air; therefore the liquid will continue to come out of the orifices a moment or two after the load has been thrown off or the speed of the motor reduced, while, on the contrary, the air issuing through the orifices in the vicinity of the gasoline jet ceases instantly, or nearly so, upon the reduction of speed or load of the motor.

The permanency of the ratio would exist without any special apparatus if we were dealing with two gases; for instance, air and illuminating gas or natural gas. The mixture of the two gases would have an inertia quite the same and they would come out of the respective orifices in a fixed proportion, once they were adjusted for various speeds and loads of the motor.

The conclusion was arrived at that with this type of carburetor some device would have to be utilized to admit more or less air and thereby increase or decrease the depression in the intake pipe, so as to keep the ratio in the proper proportion. Hand regulation of the device mentioned was at first resorted to, but this was found to be impracticable, as one never knew exactly when the carburetor was adjusted so as to maintain the proper proportion of 15 to 1, with the net result that at times the engine ran properly, but oftener it did not.

It is probable that the market price of gasoline has been, up to the present year or so, comparatively so low as to discourage endeavor in the field of utilizing kerosene or heavy hydrocarbons such as fuel oil, various crude petroleum, tar oil, etc. However, conditions are changing and will change so as to make it imperative that some other combustible than gasoline be used. Since most lines of endeavor are conducted along the path of least resistance, it would seem that the next combustible to be utilized will be kerosene. This brings us to a consideration of what has actually been accomplished in the utilization of kerosene.

DEVICES FOR CARBURETING WITH KEROSENE

The demands to solve the problem of utilizing kerosene have resulted in certain distinct types of devices, which are as follows:

1. The commonly accepted type of gasoline-jet carburetor with heat applied in various ways: (a) To the fuel itself; (b) to the air; (c) heated jacket; (d) heated jacket plus heated intake pipe.

2. Devices that will partly burn the fuel before it is admitted to the intake pipe, forming a more or less fixed gas intermingling to a greater or less extent with the vapor of the combustible.

3. Devices that admit the combustible in the cylinder direct, the valves of the motor being so regulated as to cause a partial vacuum in the cylinder prior to the admission of the combustible.

4. Where the combustible is impinged, by means of a pump or otherwise, directly upon a hot surface in the interior of the cylinder or a chamber adjacent thereto.

5. Devices that raise the temperature of the combustible to the boiling point, producing vapor but in no sense of the word a fixed gas.

1. To criticize the endeavors formulative of the first group is a comparatively simple matter. Primarily, the forces manifest in the gasoline carburetor are absolutely insufficient to turn kerosene into a fog, or rather put it in a condition such that it would commingle with the oxygen in the cylinder and be readily inflammable. Secondly, the source of supply of the heat is inconstant and is difficult to regulate. Its action lags; that is to say, when a sudden demand is made upon the motor for increased combustible, the heat requisite is not available until the combustible is actually burnt, therefore sudden variations in load and speed cannot be well taken care of by this process.

In starting the motor it is necessary to derive heat from an exterior source. This is inconvenient, however, and for stationary engines, certain classes of boats, or other applications, where a skilled attendant is available, this type of gas-making device has had and is having success.

FIXED-GAS TYPE OF CARBURETOR

2. The second type, or what might briefly be called the fixed-gas type, presents many attractive features. In starting all that is necessary is to ignite, by means of a wick, part of the combustible, no other preheating being necessary. With proper regulation of the amount of fuel actually ignited and relying upon the aspiration of the motor, a reasonably permanent gas can be formed and regulated under the adverse conditions under which we are working. The writer has operated a device of this character in extremely cold weather with gratifying results. We certainly may look forward to further developments.

3. A device utilizing this principle was experimented with to some extent by the writer, and although it was possible to start an engine cold, the cycle of events occurring in the cylinder was so divergent from normal, owing to the very late opening of the intake valve, that the experiments were discarded, and no great amount of work was done along these lines; also for the reason that the scheme introduced what appeared to be excessive complication.

4. This method of utilization of combustible is well known. It has the insurmountable fault that it is necessary to preheat the engine; this, it would appear, can be done in a practical manner only by means of some form of blowtorch, requiring

*Abstract from a paper presented at the meeting of the Metropolitan section of the Society of Automotive Engineers, New York City, May 17, 1917.

several minutes to heat the parts sufficiently to make starting certain. If a multicylinder engine, such as the prevailing types of the day, were used, the complication and trouble would make the scheme highly undesirable.

5. About the same criticism can be made for this scheme as for No. 4. It is hardly worthy of further investigation for our purpose. The idea has about all of the attendant disadvantages of the steam boiler with a few added.

In passing from the utilization of kerosene, the next logical step is to the very heavy hydrocarbons, and although there is still a great deal to be accomplished in this field, much has already been done.

For comparatively large powers and for diverse purposes the high-compression oil engine (an engine in which the compression goes to 500 lb. per sq.in. or thereabouts) is an accomplished fact, hundreds of thousands of horsepower being in daily use throughout the world. A brief description of its principle, but only a brief description, is in order.

The four-stroke cycle and the two-stroke cycle are used, and each has its advocates who claim their respective superiorities. Pure air is taken or admitted to the interior of the cylinder. This is compressed to 500 lb. per sq.in. or thereabouts, and at a point approximating the upper dead-center of the piston or slightly before, fuel is injected in the form of a fog or fine spray, and upon coming in contact or commingling with the highly heated air in the interior of the cylinder, inflammation results. This obviously increases the temperature of the air, which in turn is expanded.

Up to the present time, of all the devices used in rendering the combustible fit for consumption, the accepted form is the air injector. The function of the injector is to receive a definite quantity of combustible per cycle, which is usually propelled to the injector by means of some form of pump. It is immaterial at what portion of the working cycle of the engine this oil is delivered to the injector, provided it goes there in the proper quantity and in synchronism with the rotative speed. The quantity is a function of the load on the engine. To this same injector device, air is led from a pump or suitable container under pressures varying in practice usually from 800 to 1300 lb. per square inch.

The injector is also equipped with a cam- or otherwise-actuated needle valve. This needle valve being opened on or slightly before the upper dead-center of the piston is reached, permits the contents of the injector to come out in the form of fog, or fine spray. Another part of the injector of great importance is known as the flame plate. Its function is to divert in the proper direction the incoming spray, or fog, from the injector. This is usually accomplished by one or several small holes of suitable size pointing in the proper direction.

PROPER DIRECTION OF THE INCOMING SPRAY

This pointing in the proper direction brings up a very important feature in regard to utilizing combustible in this manner. It is essential that the entire combustion chamber be filled simultaneously or as nearly so as possible, with the combustible. If the flame plate was arranged to distribute the combustible in only one-half of the cylinder, the power and output of the engine would go down to an appreciable extent. In this respect I wish to emphasize that the high-compression engine is distinctly different from the engines utilizing fuel that has been admitted prior to the compression stroke. In this instance the compression stroke serves to a great extent to thoroughly mix the combustible with the air and presents a homogeneous mass at the time the inflammation is started. The development of the art is such that with the injector, as described and commonly used, it is possible to operate an engine at rotative speeds as high as 550 or thereabouts. Although fulfilling my theory in regard to great power to destroy the viscosity of the oil, the accepted type of injector today operating a 1000-lb. pressure per square inch is still incapable of furnishing the necessary force to operate properly at speeds higher than previously stated.

The time necessary for the oil and air to go through the circuitous passages of the holes of the flame plate, all of which are apparently essential in the breaking up of the fuel, is excessive when we contemplate utilizing this device for high-rotative-speeds or in engines for automotive purposes.

It is essential in the design of an injector to so construct it that oil will make its way to the combustion chamber in advance of the injection air. The reason for this will be better understood when one considers that the injection air is expanded from 1000 lb. per sq.in. down to 500 lb. with attendant refrigerating effect, which tends to decrease the temperature of the immediate surrounding air and render combustion slower and less positive.

A number of attempts have been made to discard the injection air and resort to solid injection. Nothing of this character has ever been attempted in this country, at least so I believe. An English firm of note, however, has apparently carried this line of investigation to a point where it is at least workable; although from reports on the subject, it would appear that the economy of their engines is lower than is customary and that they do experience a somewhat smoky exhaust with attendant difficulties which result from imperfect combustion.

In regard to internal-combustion engines of the high-compression type there is one very important feature which apparently so far has not been given a great deal of thought; that is, with the most approved type of injector and all in excellent operative condition, it is still necessary to have some 40- to 50-per cent. excess air in the cylinder to produce perfect combustion. If the engine is overloaded, smoky exhaust is produced, meaning that the inflammation is not completed during the working stroke. Obviously this is a waste of fuel, not to mention the detrimental effects upon the mechanical parts of the engine. This is indeed a most important point, because if a greater percentage of the air which is taken in per cycle could be carbureted and utilized, the size of the engine could be reduced. I have long believed that a big step in advance is due and is coming when other means is devised for subdividing the incoming fuel into finer particles than is done at present, permitting each tiny particle to become thoroughly oxygenated in the shortest possible time.

It is possible that an entirely different shaped combustion chamber than the existing types should be used; that is, a combustion chamber that will be constructed in a shape to conform with the jet of incoming fuel.

PRINCIPLES OF HIGH-COMPRESSION OIL ENGINES

I have been asked many times if it would not be possible to apply the existing principles of the high-compression oil engine to motors that would be suitable for automobiles and kindred purposes. Invariably the question has been answered, that the existing types so far are not applicable, but it must be frankly admitted that there is no really inherent reason why such a motor could not be built. It means carrying out in a proper manner the basic principles underlying the existing types, but it also means a careful study of all the mechanical parts, and a redesign along rational lines of the device now used for carbureting or breaking up the fuel and rendering it fit to be used in the motor.

When it becomes thoroughly understood that these motors can be made to operate for less than ½ lb. of fuel per brake horsepower per hour and the price of existing fuels becomes higher, the proposed idea will come about and become a reality.

Some form of two-stroke-cycle engine would adapt itself better for this class of service than the four-stroke cycle. The reason for this is that in the two-stroke-cycle engine of this category the compression pressures used, of 500 lb. per sq.in. and over, would be sufficient to counteract the inertia of the reciprocating parts with the result that the pressures on the piston pins and crank pins would always be downward or in the same direction. As this would be the case, the trouble of taking up bearings for quiet operation would be done away with. It would appear that it would be advisable to experiment and investigate along the lines of solid injection utilizing extremely high pressure, possibly as high as 6000 lb. or 7000 lb. to the square inch rather than go to the complication of utilizing air for this purpose, with its attendant multiple-stage compressor and paraphernalia. It is barely possible that experiments conducted along the line of especially preparing fuel prior to its use in the motor might materially assist in solving the problem.

THE SOLUTION OF THE FUEL PROBLEM

The fuel question is a serious one at the present time, but it is my belief that it is but temporary. The path of least resistance will undoubtedly be the application and utilization of kerosene, not as attempted through the use of existing types of carburetors, but with a device distinctly constructed and embodying the requisites for the purpose.

When such a device is brought about, it will permit the utilization of enormous quantities of this class of petroleum, which is now more or less of a drug on the market.

The next step, and especially for commercial purposes, will be the utilization of the heavier category of petroleum and such other oils as tar oil and oils from the lignites, deposits of which in the great Northwest are almost limitless.

It should be borne in mind that in an injector the following qualifications are desirable:

First, the particles of oil should enter the cylinder prior to an injection of air.

Secondly, the breaking up of the fuel is better accomplished if the oil meets the injection air in some portion of the injector at right angles. A circuitous passage is obviously desirable, but its resistance should not be too great in cases where a great number of injections are required per minute, as this delays the delivery of the fuel to the heated air contained in the cylinder and also delays the total inflammation of the mass.

Federal Trade Commission's Report on Bituminous Coal Trade

SYNOPSIS—The Federal Trade Commission makes a lucid and reliable report on the conditions ruling in the coal industry. It says that there is no scarcity of coal in the ground, that the demand for coal has increased immensely and that the shortage of cars is the main difficulty. It mentions several methods of meeting transportation needs, opposes the enlistment and conscription of miners and advocates the regulation both of the price of coal and its distribution.

The following report of the Federal Trade Commission, dated May 17 and issued May 19, is addressed to the speaker of the House of Representatives and is signed by William J. Harris, chairman; Joseph E. Davis and John F. Fort.

Pursuant to a resolution introduced by Congressman Rainey in the Sixty-Fourth Congress (H. R. 352) directing this commission to make inquiry into the conditions in the production and distribution of bituminous coal, the Federal Trade Commission presents the following report. This report is preliminary and not final.

Of late there has been a marked change in the conditions of bituminous coal production and distribution. The Federal Trade Commission has taken cognizance of these facts. There have been recently held by the commission a series of conferences in Washington and in Chicago. At these conferences there appeared before the commission representatives of the following interests: (1) Operators engaged in the mining of bituminous coal; (2) transportation lines, appearing as large consumers and carriers of bituminous coal originating on their lines; (3) representatives of municipal public utilities, manufacturing and other industrial enterprises, which are important consumers of bituminous coal.

Each of these three classes has been heard in detail, both orally and by the presentation of such written statements as they desired to make. A large mass of information has thus been gathered. The present report is based on this information, together with that previously obtained in this investigation.

THE PRESENT SITUATION

There is no scarcity of coal in the ground. There is sufficient coal available in the bituminous coal mines now being operated not only to supply the present demand, but also to supply a greatly increased demand. At present, however, there is a shortage of bituminous coal at the points of consumption.

In the East, the principal use of bituminous coal is in the making of steam for transportation and industrial use. In the Central States and the South, while most of the output is used in making steam, a part goes into domestic consumption. The unprecedented demands for this fuel during the past six months, together with the difficulties of rail and of water transportation (particularly by water to the markets of New England, the Great Lakes region and along the Ohio River), have not only absorbed the coal as fast as it could be shipped from the mines, but have also led to almost complete exhaustion of the coal stored at tidewater points, and at the docks on the Great Lakes.

In the face of a probably greatly increased demand for bituminous coal on the part of the Government for military purposes, for increased transportation, for the manufacture of munitions of every description, and for many other forms of industry, the necessity of mining and distributing more bituminous coal than ever before, both to supply current needs and to replenish exhausted storage, is obvious. The country faces a serious state of affairs in obtaining a commodity which is basic to practically every form of its military and industrial activities.

Several of the other belligerent countries have had to meet this same problem, and finding their coal supply seriously endangered, they have taken far-reaching governmental action to safeguard it. In England the Government took complete control of the coal mines after less radical methods of regulation failed. The French Government has drawn up a scheme for dividing France into three coal zones in order to equalize distribution, and the Government becomes the sole vender. On May 2, 1917, the Russian provisional government took over all the coal mines of that country with a view to control coal distribution and prices. Soon after the outbreak of the war, Germany took measures to centralize the whole coal industry of the Empire under Government control. The Italian Government imports all the coal brought into the country and acts as a clearing house for its distribution.

Recognizing the importance of this problem in the United States and the seriousness of the fuel situation, the Federal Trade Commission is making this preliminary report, based on its investigation thus far, with the thought that its information relating to the causes of this situation, and its suggestions as to possible remedies, may be of value to the present Congress.

CAUSES OF THE PRESENT SITUATION

1. Increased Demand—The marked increase in demand began to be felt about six months ago. In 1916 the shipments of bituminous coal from the mines amounted to about 509,000,000 tons, or about 66,000,000 tons more than in 1915, when previous records in production had been surpassed. Nevertheless, the demand has recently increased to such an extent that not only the unprecedented output of 1916 has been consumed, but stored coal accumulated from the production of previous years has also been practically exhausted. For example, on the docks of Duluth and Superior, there have usually been carried over, at the opening of navigation, some 3,000,000 tons, but this year when navigation opened the docks were practically empty.

The increased demand has been largely due to industrial expansion and to increased railroad traffic. In many industries plants have run two or even three shifts, while most railroads have transported more freight tonnage than ever before. In some sections of the country, particularly in the Northwest, an exceptionally cold winter led to the consumption of more bituminous coal than usual for heating purposes.

2. Shifting of Markets—Much of the increase in demand was concentrated in certain localities. There were transportation difficulties due to unprecedented burdens laid by all classes of freight on both rail- and water-transportation facilities. All this led to a considerable shift to other sources of supply in the markets usually supplied from certain coal fields. For example, coal mined in western Pennsylvania, eastern Ohio and West Virginia did not reach the markets of the Great Lakes and the lower Ohio in the usual quantities. This was because of increased demand from nearer markets, car shortage, decreased lake-transportation facilities, low water for a considerable period on the Ohio River and floods in the West Virginia mining region. Consequently the Indiana-Illinois fields have been drawn on to supply the deficit. Thus, the tonnage in commercial shipments (coal not for use of railroads) sent to Michigan from the mines of the Illinois-Indiana fields is reported to have been over 17 times as great during the nine months from April to December, 1916, as it was during the entire year preceding.

One of the important results of this shifting of markets was a buyers' panic, due to the uncertainty of consumers with regard to getting coal from their regular sources of supply. This led in many cases to a frantic bidding of buyers against each other, for that proportion of the coal supply (usually known as "spot" or "free" coal) which the mine operators were able to produce and ship in addition to the part of their output sold under contract.

The proportion of "free" to "contract" coal has varied widely between different fields and mines, but the usual estimates are that from 70 to 90 per cent. of the bituminous coal mined is usually sold under contract. Due to the inability of several of the coal fields to adequately supply their usual markets, and to the great increase in the demand for coal, which had not been foreseen and contracted for by the consumers, the prices of "free" coal have risen enormously in all the markets.

3. Inadequate Transportation Facilities—While, as previously pointed out, there is no lack of coal in the ground, or of mines from which it can be obtained, the fact must be borne in mind that few soft coal mines are equipped to store coal. The coal must be loaded into railroad cars as fast as it comes out of the mine. As a general rule, miners do not go into the mine unless the cars necessary to take care of the day's output are on hand at the mouth of the mine.

Cars enough to carry away the coal as fast as it can be mined are therefore a prime necessity. During the past six months, from a variety of causes, the railroads have not furnished or have not been able to furnish cars equal to the productive capacity of the mines. Furthermore, where coal has to be carried part of the way by water, there has been difficulty in getting enough boats.

The principal causes for a lack of adequate rail transportation have been: Car shortage, embargoes on the movement of freight cars, lack of sufficient motive power and, to some extent, abuse by shippers and consignees of reconsignment and demurrage privileges. Car shortage in some cases appears to have been due to lack of sufficient cars suited to carrying coal; in others, to the diversion to use in other industries of cars generally available for the movement of coal and in others to the much longer hauls required, due to the shift of markets from their normal sources of supply, which required more cars than usual to distribute the same tonnage.

Lack of terminal facilities adequate to handle the immense volume of freight consigned to certain points resulted in great congestion at those localities. Railroads on whose lines the shipments originated had to place embargoes against shipments consigned to such destinations, until the congestion could be relieved. In some cases there was also a lack of sufficient locomotives to move the coal from the mines to the consumer. Some of the car shortage appears also to have been due to abuses by shippers of reconsignment privileges, and of consignees of demurrage privileges in the unloading of cars at destination. In some instances mine operators and brokers appear to have taken advantage of such reconsignment and demurrage privileges so as to secure a temporary storage of coal in connection with speculative activities to obtain extortionate prices from coal consumers.

The principal causes for a lack of adequate water transportation have been: Diversion of boats in the coastwise coal trade to other lines of ocean traffic; diversion of boats in the lake coal trade to ocean traffic, and the conflict of the demand for iron ore and grain transportation with the demand for coal transportation.

COAL LEFT ON DOCK AND WATER FREIGHT TAKEN

This conflict has occurred because of the higher freights paid for eastward-bound iron-ore and grain transportation than for westward-bound coal. The delay incident to loading and unloading coal, and the fact that three of the highly profitable grain or ore cargoes could be transported in the same time in which only two could be carried, if coal were taken westward, has resulted in boats, suitable for carrying coal, going westward empty, using water as ballast instead of coal.

4. Labor Conditions—Statements made at the commission's hearings by mine operators from different coal fields indicate that in some regions there has been and still is an actual shortage of mining labor. The following reasons are generally ascribed: 1. The wages offered in other industries are often higher than those paid in the mines. 2. The lack of full-time employment in coal mines due to insufficient car supply often necessitates shutting down the mines from two to three days in the week, and sometimes running them only part of a working day. Since many of the men are paid on the basis of the tonnage they mine, the resulting enforced idleness cuts down the actual wages received. 3. There has been a considerable emigration of alien miners, who have been called to the colors of the various warring European nations, and there has been little new immigration from any source to fill their places. Some of the Southern mining fields have been seriously hampered by the movement of negro laborers to the North, generally to other industries than coal mining. This migration is probably ended.

5. Increased Costs of Production and Distribution—Considerable information in regard to increases in costs of production and distribution was submitted by coal operators at the commission's hearings, or has been gathered directly by the commission's agents. These increased costs, as far as production is concerned, are comprised chiefly in cost of labor. While there has been a great increase in the prices of supplies, the increase in the cost of supplies per ton of coal has been a much less important factor than is generally claimed. In the distribution there has also been some increase in cost, mainly in increased cost of transportation to the point of consumption.

The figures already submitted to the commission in regard to costs and to prices at the mine show that most of the present prices now being charged, both on "free" coal and on such few new contracts as the mine operators are entering into, are far in excess of the costs as shown by the operators' books. Many of the operators frankly take the position that they are trying to get for their coal the highest price possible under the present demand, and are refraining, even at prices greatly increased over last year, from contracting their output to the extent of their usual custom.

They defend this action by claiming that under the operations of the law of supply and demand they have for many years past been getting little more for their coal than the bare cost of production; that the mining of bituminous coal during that period has been a most unprofitable industry; and that this is their chance to recoup themselves for the losses of several years. Accordingly, they are demanding prices at the mine today, which run from fifty per cent. to several hundred per cent. over the cost of their output.

As a result of this policy, much of the bituminous coal output has been auctioned off to the highest bidders. This has resulted in great profits to certain operators and in special hardship to municipal public utilities, hospitals and other public and private charitable institutions, and to domestic consumers, especially in the West and South, where relatively little anthracite is used.

6. Lack of Sufficient Storage Facilities—The most economical way of handling coal is by loading it into cars as it comes from the mine, transporting it to the point of consumption, and delivering it in the same car direct to the retailer or large consumer. At times, there are adequate transportation facilities to keep the coal moving steadily in this way. But the consumption of bituminous coal is largely influenced by seasonal changes, the demand normally being heavy in fall and winter months, and lighter in the spring and summer.

This leads, in normal years, to frequent shutting down of mines, because of lack of orders, at a time when there are plenty of coal cars, and conversely to traffic difficulties at other times, largely due to inability to secure enough cars to care for the current demands. The obvious remedy for such a state of affairs is the establishment of storage facilities, preferably near the centers of consumption.

But the relatively great expense of storing coal has prohibited any general establishment of adequate storage facilities. Thus it has happened that many times during the past six months the chief cities of the United States have been faced with a coal shortage which threatened to stop their street cars, cut off their electric light and power and their gas, and shut down the manufacturing industries which support their population.

7. Speculative Activities of Some Mine Operators and Brokers—As already pointed out, from 70 to 80 per cent. of the output of the bituminous coal is sold under contract by the mine operators. It is estimated that the railroads of the country consume about one-third of the total production of bituminous coal. Practically all of the railroad supply, in normal times, is under contract. Of the "free" coal produced by the mines, probably about half is sold by them direct to the consumer. The remainder of the "free" coal and a small part of the coal sold under contract reaches the ultimate consumer through the medium of middlemen, such as brokers and retailers.

Charges of extortionate prices on the part of mine operators and brokers have been brought to the attention of the commission. According to some informants, various mine operators and brokers, through abuses of the reconsignment and demurrage privileges granted by railroads in order to facilitate the regular distribution of coal, have created or increased local shortages and extorted exorbitant prices from the consumers. These charges are now under investigation by the commission.

SUGGESTED REMEDIES

The remedies which may be suggested for the present scarcity and high prices of bituminous coal relate to its production, transportation and distribution. The most effective remedies deal with the improvement in the distribution of the present facilities for transportation. Many operators asserted at the hearings before the commission that such remedies were the only ones necessary. On the other hand, the representatives of the railroads, municipal public utilities and industrial consumers, while admitting the importance of such improvement, pointed out that there were other conditions which need remedy.

1. Improvement of Transportation Facilities—At the hearings of the commission the fact was brought out that measures are being taken by the Interstate Commerce Commission and by the Council of National Defense which it is hoped will relieve transportation conditions. For railroad carriers, additional regulations are being considered covering the distribution of open-top cars to the coal industry, the expediting of the movement of cars loaded with coal, and the return of the empty cars to mines, prevention of the abuse by speculators of reconsignment and demurrage privileges, and the providing, where necessary, of additional equipment for use in transporting coal, both cars and locomotives, either by acquiring

new equipment, or through possible changes in other lines of traffic, such as dispensing with passenger trains which are not absolutely necessary and thereby releasing more locomotives for freight service.

For water carriers, remedies should be sought along the lines of requiring boats, suitable for coal carrying on the Great Lakes, to transport coal westward, instead of going back in ballast for grain and ore cargoes, and in adjusting the rail conditions so that there will be sufficient transportation facilities to carry the coal from the western Pennsylvania, eastern Ohio and West Virginia mines to the loading docks on Lake Erie, for prompt loading of the boats.

The limited period that the lakes are open to navigation makes it necessary that the carrying capacity of the boats be kept in continuous use. Early remedial action is necessary because every week of the navigation season is of tremendous importance in preventing shortage of coal in the Northwest next winter.

The principal remedy suggested for conditions in the coastwise water transportation of coal, apart from the building of more boats, is the exemption from military use of tugs and barges absolutely necessary to transport not only the coal, but also the timber needed for mine use.

2. Improvement of Labor Conditions—It was developed at the hearings on the part of the operators that they anticipated that labor conditions in 1917 would permit, if mining operations could be kept steady by a continuous supply of cars, the production of as much coal as that mined in 1916, and some of them stated that with their present force they could mine an excess of from 15 to 20 per cent. over their output in 1916. If this statement is accurate, the operators in the coming year will supply more bituminous coal than in 1916. The recent increases in wages and the better housing conditions, which are being provided for miners, will, many operators believe, not only hold their present force, but to the extent to which they would attract additional labor would bring about an increased output.

It will probably be found necessary to exempt miners from the conscription law, so long as they remain at work in the mines. The experience of Great Britain in this matter should be heeded, and the disastrous results which came from the enlistment of miners avoided. Everything should be done to encourage men employed in the coal mines to stay on their jobs and to realize that it is their duty, as patriotic citizens, not to leave the mine even to enlist, but to see that they are serving their country best by remaining at their labor to produce the commodity which is absolutely essential to sustain all the forces which must be quickened and employed in the prosecution of the war; that their post of honor is at the mine and not on the firing line.

3. Establishment of Increased Storage Facilities—It is highly desirable that additional storage facilities be provided at points of consumption. Municipal and other public and semipublic utilities and institutions should safeguard themselves not only against being shut down, but also against being forced by their urgent necessities to buy coal at exorbitant prices. The railroads, which consume about one-third of the bituminous coal mined, should increase their storage facilities and avoid the necessity of holding cars loaded with coal for railroad use.

4. Regulations by Governmental Authority for the Distribution of Coal—Under war-time conditions it may become the duty of the Government of the United States to take steps similar to those found necessary by the belligerent European countries, and not only regulate the distribution of the coal from the mouth of the mine to the ultimate consumer by allotting the quantity of the product which the different classes of consumers shall be allowed to purchase, but also to establish the prices to be paid by different classes of customers.

Any prices thus established would probably have to be based on actual costs, with an allowance for a reasonable return on actual investment. In other words, the price of bituminous coal, which is a great public necessity, should be fixed according to the same general principle which has been established in the conduct of public utilities. At a time like the present, excessive profits should not be permitted to be extorted from the public by producers and distributors of any prime necessity of life.

Wentworth Institute Exhibit

The Wentworth Institute, Boston, had an exhibit of the work of its day classes Wednesday, June 6. The institute is one of Boston's largest industrial schools, devoted chiefly to the mechanical arts.

In the issue of Aug. 1, last year, attention was called to a course in power-plant engineering for which the institute was then preparing. This course was, perhaps, the first of its kind in such an institution. The first year of the course has been completed and has exceeded expectations, Arthur L. Williston, the principal of the institute, advises. The steam laboratory is in the building with the service power plant. Three complete engine and boiler units are provided: The service unit, consisting of the Babcock & Wilcox boiler and a Corliss engine and generator; another boiler of the same type, connected to a high-speed engine and generator recently installed; and a locomotive boiler with an old-type Corliss engine. Each unit is complete with feed pump, injector, etc. Several small engines, operated by compressed air, are provided for practice in valve setting.

Following the practice in all other departments of the institute, a combustion laboratory, with all necessary apparatus, joins the steam laboratory. Students in the power-plant class take mathematics and machine-shop practice; they are also given a brief course in foundry work to acquaint them with methods and to enable them to tell good from bad castings and why. Here, again, science is made the servant of industry, as the metallurgical laboratory connects with the foundry, machine shop and the heat-treating laboratory. The work of all these departments furnished interesting exhibits.

One of the most interesting laboratories is that devoted to applied science. It is difficult to visualize the play of forces in trusses, beams, cranes and various structures. To assist the student here the various members of such structures are arranged so that spring scales show the load on each member. This laboratory made an instructive exhibit.

Army engineering is being taught, and the sight of uniformed soldiers engaged in bridge building and other army-engineering problems gave one an idea of the thoroughness with which the enlisted men are being taught the work that they are soon to do. It is intended to train these men in all such work as bridge building, concrete structures, and steam, electrical and sanitary engineering as related to the army. These men are not of the classes of the institute, but are from the enlisted ranks.

Other interesting exhibits were those of the departments of machine design, mechanical drawing, masonry and printing—the last a new department.

Southern California Power Corporations Consolidate

The California State Railroad Commission has granted the application of the Southern California Edison Co. and the Pacific Light and Power Corp., operating at Los Angeles and vicinity, for permission to consolidate. By the merger the Edison company will acquire the properties of the Pacific Light corporation and its subsidiary, the Ventura Power Co., with a system in Ventura County, for a consideration of $4,000,000 in cash and $12,029,900 par value of second preferred stock.

The properties, as valued by the engineers of the companies, including hydro-electric and steam power plants, transmission and distributing lines, represent an aggregate investment of $30,311,329 and $32,921,392 for the Edison and Pacific Light companies respectively, or a total of $63,232,721. The engineers of the commission, following a detailed examination of the combined properties, place a total valuation on the dual system of $54,018,235, and with depreciation allowance, $45,266,387. The Southern California Edison Co. has a total capitalization and debt of $34,248,602 and the Pacific Light and Power Corp., $51,108,496, or collectively, $85,357,098.

The complete system will be operated under the name of the Southern California Edison Co. It will consist of 13 hydro-electric power stations, including Big Creek and Kern River, with a total generating capacity of about 150,000 hp., and five steam plants at Long Beach, Redondo and Los Angeles, with an aggregate capacity of 125,000 hp., giving a combined total of approximately 275,000 hp., with over 100 substations. The system comprises about 1400 miles of transmission lines and 3700 miles of distributing lines, serving over 150,000 consumers in 150 municipalities. The company also controls water properties capable of a development of from 300,000 to 400,000 hp., in addition to present capacity. In approving the consolidation the commission says:

> The Pacific Light and Power Corp. has a large hydro-electric development which is not and will not in the near future be put into full use unless this consolidation occurs. On the other hand, the Southern California Edison Co. is using to capacity its hydro-electric installations and, unless this consolidation occurs, will be confronted with the almost immediate necessity of increasing its production of electric power. Therefore, by this consolidation there are brought together two systems which complement each other in this respect. The considerable surplus of power now possible of generation in the plant of the Pacific Light and Power Corp. will be brought into use for the consumers of the Southern California Edison Co., and this will provide for a very considerable expansion of business by the consolidated company without the necessity for large expenditures in increasing production capacity. Furthermore, it is proposed to completely consolidate these plants and to operate thereafter as a unified whole, thus greatly decreasing operating expenses.

The companies figure that the annual saving as a result of the merger will closely approximate $400,000 and are supported in this estimation by the commission, which takes the view that the consumers will be benefited by the consolidation through the elim-

ination of the necessity for duplicate facilities and the greater efficiency made possible by the serving of the community with one general plant and organization, as well as by the possibility of lower rates in the future for consumers of the consolidated company.

Preventing Corrosion in Hot-Water Supply Pipes

In a paper before the annual meeting of the American Society of Heating and Ventilating Engineers, F. N. Speller, engineer, National Tube Co., Pittsburgh, Penn., gave a detailed account of experiments in the prevention of the corrosion of hot-water supply pipes by deoxidizing the water used in the system. In a paper presented to the same society a year ago, Mr. Speller pointed out that free oxygen and carbonic acid in water have been proved to be the cause of practically all the corrosion trouble with hot-water supply lines. There are two methods for the removal of the gases from the water: First, by liberating the gases to the atmosphere—for example, by the use of an open-type heater under atmospheric pressure or partial vacuum; secondly, by keeping the hot water under pressure in contact with a large surface of iron for sufficient time to remove and "fix" the oxygen and carbon dioxide.

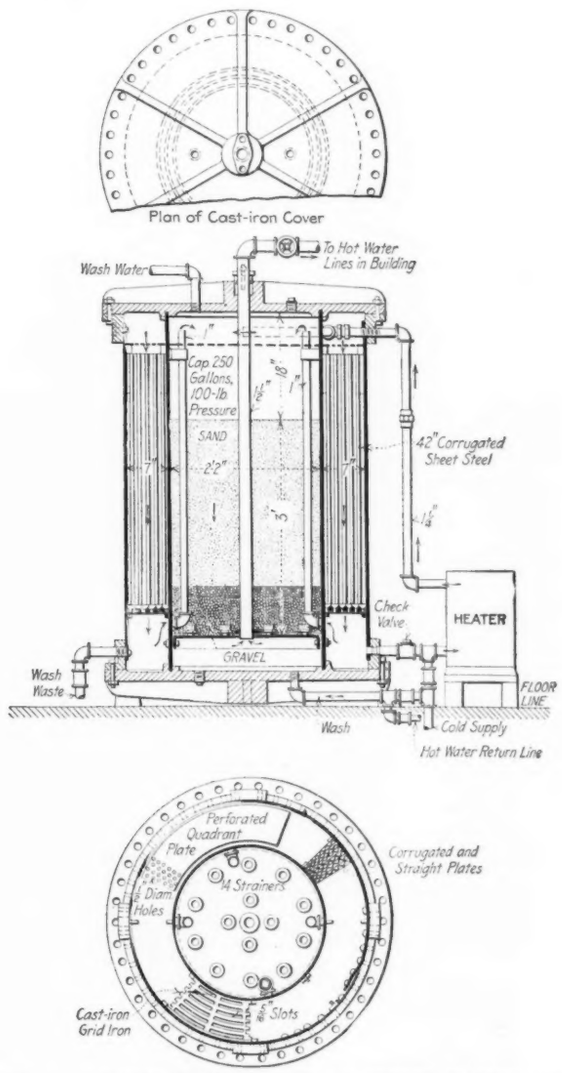


FIG. 1. DEOXIDATION PLANT AT IRENE KAUFMANN SETTLEMENT

In his recent paper Mr. Speller describes the results of experiments at the Research Laboratory and Hospital Building of the National Tube Co. at McKeesport, Penn., and at the Irene Kaufmann Settlement, Pittsburgh, Penn. Both installations have demonstrated that the corrosion of iron or steel can be arrested and practically eliminated by the processes mentioned.

At the Irene Kaufmann Settlement, which was built in 1910, wrought-iron and steel pipes for the hot- and cold-water lines were used, one branch of the system supplying the pool and showers and the other the residents and laundry. All the hot-water piping showed signs of serious corrosion by 1915, many lines having then been replaced with brass pipe, the replacements and repairs being needed frequently.

At this institution a new experimental hot-water heating system to supply the residents and laundry was put in use in December, 1915. The apparatus consisted of a storage tank filled with alternate pieces of corrugated and plain steel sheets of No. 26 gage arranged radially around a filter, as shown in Fig. 1. The water was heated by a No. 2-B Stewart heater (3 gal. per min.) and passed downward between these plates, being deoxidized. The water then flowed upward through the pipes to the top of the filter and downward again through the filter and finally up through the central pipe to the system. The return was brought in underneath the filter bed.

In these deoxidizing plants the oxygen and carbon dioxide are absorbed by the pieces or sheets of steel, which rust away. This robs the water of its ability to seriously corrode the piping system, provided the water does not absorb appreciable oxygen after passing the deoxidizing plant.

Fig. 2 is a diagrammatic layout of the deoxidation plant at the National Tube Works at McKeesport. In this plant disks of "Cambridge" metal lath were used. Strips of this or other suitable form of sheet iron may be used, provided it is spaced so as to fill the chamber and yet leave a cellular structure with openings not over $\frac{1}{4}$ or $\frac{3}{8}$ in. through which the water can freely circulate. Attempts to use iron filings for this purpose failed because they would pack tight after but little use. Rust occupies a space several times that of metallic iron, and this must be provided for. The average daily consumption of treated water at the Irene Kaufmann Settlement varies from 600 to 1200 gal. per hour. In the other system, using untreated water, somewhat less is used. The normal temperature of the water is 170 deg. A series

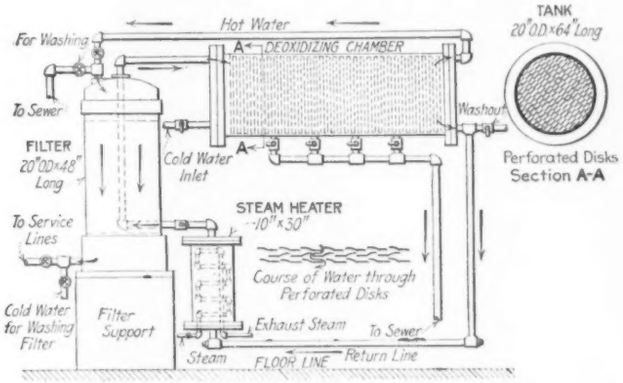


FIG. 2. DEOXIDATION PLANT AT NATIONAL TUBE WORKS

of analyses of the water showed that the oxygen content before treatment was about 8 c.c. per liter, and after treatment, 0.5 c.c. per liter. The reduction in the rate of corrosion effected by this reduction of the oxygen content is significant, as shown in the next paragraph.

Experiments carried on further by Mr. Speller indicated that water that had been in contact with the plates of the deoxidizer still carried considerable gas in solution, but that this gas consisted mainly of hydrogen and nitrogen. The hydrogen frequently ran as high as 20 per cent. It is also of interest to note that from gas analyses and oxygen determinations made from time to time, the rate of removal of oxygen has not diminished the length of service. Plates that were removed from the McKeesport plant after eight months' service had a thick layer of rust over the surface, but the efficiency of the deoxidizing tank was even greater after use. Except with water carrying organic matter and clay in suspension, we should expect this to be the case. The experiments have shown that assuming raw water to contain 9 c.c. of free oxygen per liter and that it is completely deoxidized, about 220 lb. of iron will be used in treating 1,000,000 gal. of water at this rate. Figuring the cost of sheet-iron scrap at 2c. per lb., the cost for material for deoxidization of water is well within the usual costs of chemicals for the treatment of boiler water.

The paper containing this information is in the form of reprint and, we understand, is obtainable from the National Tube Co., of Pittsburgh, Penn. The details of the test are given in this paper.

American Order of Steam Engineers Meets at Philadelphia

The thirty-first annual convention of the American Order of Steam Engineers was held at Philadelphia, Penn., June 4 to 8, with headquarters at the Hotel Vendig. The several business sessions of the delegates were held in the Parkway Building, conveniently situated near the headquarters. The main hall of the building was tastefully decorated and arranged for the mechanical exhibit of engine-room supplies and power-house equipment, under the supervision of the American Supplymen's Association. Seventy booths were occupied, making an interesting and instructive display. The committee had advertised the exhibit extensively, and the hall was filled to capacity each night. There was a full attendance of delegates this year, and many important measures conducive to the uplift of the organization were discussed and passed upon. The reading of the treasurer's report shows the order to be on a sound financial basis. At 8 o'clock Monday evening the official opening of the convention and exhibition took place, with Past Supreme Chief George Richardson in the chair. George Datesman, director of public works, welcomed the convention to Philadelphia. Supreme Chief J. William Pairent told of the increasing necessity for efficiency in the engineer. He complimented the Supplymen's Association for the neatness and completeness of its exhibition and thanked the salesmen for their help in making the convention a success. William Schraeder, of the Philadelphia Bar Association, expressed the hope that in the near future there would be a universal eight-hour law for all operating engineers. Alfred Smith, president of the Supplymen's Association, assured the engineers of hearty support and thanked them for their interest in the exhibit.

DELEGATES TO A. O. S. E. CONVENTION—ENGINEERS

The entertainment features were a five-hour sail on the Delaware River on Tuesday afternoon and an automobile ride to Valley Forge on Wednesday afternoon. Because of wet weather the outing and field day set for Thursday afternoon was transferred to the large hall in the basement of the Parkway Building, where a general good time was had, dancing being the principal amusement.

On Wednesday evening there was a combined session of the engineers and supplymen to commemorate the annual memorial services.

The delegates elected the following supreme officers: J. William Pairent, chief engineer, Philadelphia Council No. 7; John McKewen, first assistant engineer, Maryland Council No. 1; John Martin, recording engineer, Kensington Council No. 3; William S. Wetzler, corresponding engineer, Philadelphia Council No. 7; William H. Tyson, treasurer, Municipal Council No. 20; Charles O. Henty, senior master mechanic, Germantown Council No. 22; Harry Oler, junior master mechanic, Camden Council No. 3; James Steigerwald, inside sentinel, Lehigh Council No. 15; Edwin M. Brooks, outside sentinel, Energy Council No. 2; John McAllister, chaplain, Capitol City Council No. 2. The following trustees were elected for one, two and three years respectively; James K. Holland, Southwark Council No. 4; D. B. Heilman, Progress Council No. 13; John Best, Atlantic City Council No. 4. At the final meeting of the American Supplymen's Association the following officers were elected: Horace A. Smith, president, Philadelphia Grease Co.; Porter G. Jones, vice president, Dearborn Chemical Co.; Roy Downs, secretary, Lord Boiler Compound Co.; John W. Armour, treasurer "Power." William Lindenfelser, Jr., The Texas Co., was reappointed director of exhibits. The retiring president, Alfred Smith, was presented a silver service, the gift of the supplymen.

MEMBERS OF AMERICAN SUPPLYMEN'S ASSOCIATION

Injury to Pedestrian—In affirming judgment against the owner of premises on which a steam pump was operated, for injury to a child caused by discharge of a jet or stream of hot water from the premises into a public highway where the child was playing, the Massachusetts Supreme Judicial Court holds that defendant could not avoid liability by showing that the pump was installed and guarded in a manner customary under such circumstances, if it appears that the conditions were such that the accident might have been foreseen in the exercise of a reasonable degree of care for the safety of passers-by. (Northeastern Reporter, 205.)

Honors First National President of N.A.S.E.

New Jersey No. 3, Newark, National Association Stationary Engineers, recently celebrated in honor of Henry D. Cozens, the first national president of the National Association of Stationary Engineers and a member of Newark No. 3 Association, by unveiling a large picture of Mr. Cozens, inclosed, with the preamble of the association engraved, in a beautiful mission frame. Some time previous to the unveiling of the picture, Newark Association was honored by a visit from Fred W. Raven, national secretary of the association, Henry J. Mistele, of the association's board of directors, and Joseph O'Connell, also of the board. At the time Mr. Raven presented Mr. Cozens with a national president's badge. It was on this occasion that the association decided to have a large picture of the first national president made and hung in its hall. Charles H. Bromley, instructor to the association, in unveiling the picture, spoke in part as follows:

The preamble today is as it was written by Mr. Cozens nearly 35 years ago. As the years go on and as the requirements of the operating engineer become more complex and more technical, we will have a deeper appreciation of the value of the association as Mr. Cozens conceived it and as it has been developed by others who have followed him. More and more, conditions in the field of power-plant engineering prove that the aims of this association, as laid down in the preamble, namely, that "this association shall at no time be used for the furtherance of strikes. . . . Neither shall it be used for political or religious purposes. At all times preference shall be given to the education of engineers and to securing the enactment of engineer's license laws, . . ." are fundamentally correct.

One need not go into details to convince his hearers that the greater efficiency in industry demanded by the astounding advances in the industrial arts and the plans now being arranged for competition for world trade after the war will call upon the power-plant man to produce his best, with comparatively little time to prepare. Organization is what will do this quickest. That we have. Let every man do his best to meet the organization work for him in giving him the training he will need.

Mr. Bromley urged every association in the national body to have hanging in its meeting room a duplicate of the portrait of

the distinguished first national president. The association has made arrangements to provide these to associations that want them at a cost of $6 each. The picture is shown herewith. Address Joseph G. Fisher, Secretary, 104 Branford Pl., Newark, N. J.

Mr. Cozens spoke of the early history of the association. Having its beginning in the Providence Association of Stationary Engineers, organized December, 1879, the creation of a national association of engineers was, Mr. Cozens believed, a big way to meet a big need. Thereupon many engineers about the country were asked to join the movement. Brooklyn, N. Y., was first to respond, then Chicago, Detroit, Rochester, Boston, New York, Philadelphia, followed in the order named. The first convention was called to order by Mr. Cozens in Lithographers' Hall, New York City. In his address Mr. Cozens read the preamble he had prepared, which is the same as is used today.

Chris Holden, then sheriff of Providence County, Rhode Island, allowed Mr. Cozens, who was at that time subordinate to Holden, to visit cities and organize associations. In 1883 Mr. Cozens went on the staff of the Boston "Journal of Commerce," and while with that paper traveled the Atlantic States, which gave him an opportunity to organize many associations. In the meantime Mr. Alonzo Davy, of Detroit, and Messrs. Beckerleg and Miner, of Chicago, were active organizing in the Middle West.

Not knowing its purposes, employers feared the organization would give labor trouble and were therefore not favorably disposed toward it. To avoid this the services of George H. Corliss, inventor of the Corliss engine, Channing Whittaker, of the Massachusetts Institute of Technology, William A. Harris, of the Harris-Corliss Engine Works, Z. Allen, inventor, and Fred R. Low, editor of "Power," were gladly given, many employers and mill superintendents attending the addresses made by these men. Among those early lecturing to the association were George Dimon, well known as the chief engineer of the famous Amoskeag Mills, and Thomas Pray, remembered for his early lectures on the indicator.

A first-aid-to-the-injured class, organized and instructed by James C. Savage, chief operating engineer for the Clark Thread Co., was recently graduated in the association rooms. The graduating class numbered 13 members of the association. This is the first association to organize first-aid classes; the members are also members of the American Red Cross.

Refrigerating Engineers Meet in Milwaukee

On June 7, 8 and 9 the American Society of Refrigerating Engineers held its fifth Western meeting at the Hotel Pfister, Milwaukee, Wis. For a spring meeting the attendance was good, and a lively interest was shown in the material presented, discussion centering on autogenous welding, the flooded system, types of condenser and the electrically operated ice plant.

The convention opened with the reports of the tellers of election of members and of the various standing committees, the latter being for the most part reports of progress. The committee on Municipal and State Regulations for Refrigerating Plants and Refrigerants had prepared a code for the Cities of Troy, N. Y., and Newark, N. J. The code is only tentative, to serve until something better can be formulated. It contains safety regulations for the public and the plant operator and requirements to protect the city firemen from the dangers of an ammonia explosion in case of fire. The code will be given further attention in an early issue.

The subcommittee on welding impressed on the convention the need of haste in preparing a satisfactory code on proper methods of making and testing welds, maintaining that a satisfactory code to offer legislative bodies will tend to insure uniformity and prevent a wide variation in requirements sure to result from the individual efforts of municipal or state authorities. Unless convinced of the safety of autogenous welding and there is something definite to present to them upon request, there is danger of regulations ignoring altogether this form of welding. There is a great deal of work to be done in gathering and sifting information on the subject. Help from the manufacturer's committee and other sources will be necessary. Funds are required and the need of a paid secretary to carry on and coördinate the work of the committee was suggested in President Hiller's address immediately following the discussion. Continuing, the president commented on the value of branch associations in adding to the membership and increasing interest in society affairs.

At the afternoon session Donald Cole presented a paper on the "Power and Labor Requirements of the Detroit Type Ice Plant." These are electrically driven raw-water plants ranging in capacity up to 120 tons and provided with storage houses to maintain constant production. Including the auxiliaries, which take about 15 per cent. of the total, the average power requirement per ton of ice produced is 50 to 56 kw.-hr. Subdivision of this total for the various parts of the plant and the labor required was interesting information. Monthly operating data from typical plants were also given. In the discussion it was brought out that the storage house did not improve economy, but insured service to the public, ice being available in the summer, when most needed—even during a shutdown.

A paper on "Performance of Raw Water Can Ice Plants," by Van R. H. Greene, was read by the secretary. It outlined the operation of the raw-water system, dwelling particularly on the

removal of air, the pressure and quantity of the air used for agitation and the advisability of filtering or treating the water. Neither the suspended mineral matter nor the organic matter should exceed 2 grains per gal. In the discussion it was made evident that every water supply is a problem in itself, requiring individual treatment. From some waters, particularly in the South, it is impossible to make clear ice with the raw-water system.

Discussions on the proper vapor velocity for ammonia suction and discharge mains and on the prevention of accidents in refrigerating plants ended the session. It was shown that suction velocities, depending on conditions, vary from 2000 to 5500 ft. per min., a good average being 3000 to 3500 ft. per min. The discharge velocity ranges from 5000 to 7000 ft. per min. It is important to have a free suction. The pipe size should be chosen so that the drop will not exceed 1 lb. The length of the line is an important factor, and strict attention to traps is imperative.

With Theodore Vilter as toastmaster, the success of the banquet Thursday evening was assured. High-class vaudeville entertainment interspersed the usual after-dinner talks.

"Circulation in Flooded Systems," by A. H. Baer, the first paper at the morning session, Friday, included a description of some interesting experiments made for the purpose of observing the behavior of liquid ammonia evaporating inside of cooling coils. The paper dealt with direct and gravity-flooded systems, discussing operating features and efficiencies. On the latter some flat statements without proper data to back them aroused much unfavorable comment.

A most interesting paper on "Welded Containers" was read by Charles Hollup, a practical welder thoroughly understanding his subject. The speaker outlined welding methods, construction and preparation of work to be welded, tests as to safety and the strength of welds and practical application of welded work in the manufacture of refrigerating machinery. Numerous lantern slides showed samples of welding and results of tests on containers. Of the three methods—electric resistance, electric arc and oxyacetylene welding—Mr. Hollup preferred the second as easier to teach and giving uniformly better results than the oxyacetylene method. More of this paper will be printed later.

OXYACETYLENE WELDING DEFENDED

Following, Mr. Cave presented the advantages of oxyacetylene welding, pointing out that in electric welding it is difficult to maintain the arc, owing to the constant shortening of the electrode, and on this account few men can perform the work satisfactorily. Contrary to the general view welds have ductility. A sample was presented showing an elongation of 41 per cent. in the welded metal. From the standpoint of safety it is important to make sure that the equipment used is capable of making a strong weld, that the operator is competent and that the firm, which should be licensed, has the necessary technical knowledge.

Thomas Andreson, of Chicago, stated his belief that oxyacetylene welding is safe and practical, provided the proper material and methods are used. He said that Chicago had been permitting it for some time and at one time allowed an efficiency of 80 per cent. for the welded joint. This was excessive. He had reduced the efficiency allowable to 50 per cent. and upon satisfactory evidence from the manufactures committee had finally raised it to 60 per cent. He presented for inspection a number of samples, which had been welded by the Vilter, Vogt and York companies and had been tested in Chicago, and which showed efficiencies of 75 to over 100 per cent. Where the weld had been reinforced, the efficiencies were in the eighties. Annealing in one case increased the strength to 96 per cent. of the solid plate. The 75 per cent. had been obtained from a weld that had been filed off even with the metal of the test piece.

The speaker said that there were some 900 plants in Chicago and even with the former allowance of 80 per cent. only one accident due to failure of a weld had occurred. With proper inspection autogenous welding is reliable. A uniform code, however, for the installation and safe operation of cooling plants is badly needed. He expressed the hope that the society would take action in this direction at an early date.

The discussion turned to internal stresses in the welds, the value of annealing to neutralize the stresses and methods of performing fatigue tests on welded containers. X-rays have been used to determine the completeness of a weld. A slight flaw could be detected, but the structure of the metal or internal strains would not be evident. One way to determine the structure of the weld without destroying the vessel is to take out a small section, cut it in two and etch the pieces. The hole can be plugged mechanically or welded. In a long weld a number of these samples can be taken.

Otto Luhr pointed out that there were internal strains in any type of joint and that this factor should not eliminate the use of autogenous welding. It is necessary to establish a proper factor of safety and test hydraulically or otherwise. Almost invariably poor welds would show up at the time of testing. Safety valves can be used on large vessels.

Theodore Vilter remarked that ammonia containers have the advantage over steam vessels that they are not subject to wide variations in temperature. It is necessary, however, to educate the welder and only permit competent men to do such work. Henry Vogt expressed the same sentiments and made a strong plea for proper inspection as to the strength and the design of the weld.

Valuable data in the form of charts and tables were presented by Harry Sloan in his paper on "The Electrically Operated Ice Plant." Methods of designing a well-balanced plant and of analyzing a plant in service were advanced, with full discussion on the various factors entering into efficient operation. Mr. Carlson, of the Commonwealth Edison Co. of Chicago, contributed to the discussion, presenting copies of the company's daily ice-plant record and operating data from 21 Chicago plants using central-station power.

"Ice Skating Rinks," by M. R. Carpenter, was the final paper of the convention. At the close of the session an inspection trip was made to the Schlitz Brewery, and on Saturday all were invited to the Vilter works to inspect the welding department of the company and to see how different types of weld are made.

MISCELLANEOUS NEWS

The New Jersey State Purchasing Commission, Trenton, is arranging plans for the installation of new equipment at the boiler plants of state institutions to reduce the present cost of fuel, averaging $150,000 a year, more than one-third, or about $54,000 in a twelve-month period. Under the direction of the State House Committee, investigations have been made at the different plants with findings indicating that the expenditure of approximately $150,000 for new grates, mechanical stokers, ash carriers and kindred equipment for the various boiler houses will result in the saving mentioned. In this it is planned to reduce the size of the grate bars to allow the use of fine "rice" coal, heretofore regarded as waste, which is obtainable at low cost at the mines, while the stokers and ash-handling equipment will go to increase the operating efficiency and reduce the labor expense. The proposed work includes the plants at the following institutions: Rahway Reformatory, equipment cost $60,000, with estimated yearly fuel saving of $17,000; Morris Plains Hospital, $45,000, with estimated saving of $24,500; Trenton State Hospital, $31,000, with estimated saving of $10,000; and Vineland Home for Feeble-Minded, $7000, with estimated saving of $3000.

The New York Edison Co. has petitioned the Public Service Commission to relieve the company of its tentative promise to reduce its rates from a maximum of 7½c. to 7c. per kw.-hr. beginning July 1, the reason set forth by J. W. Lieb, vice president of the company, being the vast increase in the cost of everything that enters into the production of electric power. The promise was made in November, 1916, with the stipulation that if business conditions would permit, the lower rate could be applied; the company now claims that the present conditions will not permit the lower rate. However, Mr. Lieb admitted before the commission that the company's net income had increased since the rates were reduced from the maximum of 8c. to 7½c. per kw.-hr. On the stand Mr. Lieb said: "We wish to lay before the commission the changed conditions, and we wish to argue the commission from the point of view that we should not at this time be required to take the further step contemplated last fall; namely, a reduction in our maximum rate to 7c. per kw.-hr. We do not desire to return to the old rate of 8c. per kw.-hr., but to remain at the present rate of 7½c." The hearing was postponed until June 20, so as to give Mr. Lieb an opportunity to prepare a detailed statement of the increase in operating expenses that had occurred.

Suspending Natural Gas for Steam Production—With a view to the necessity for limiting natural-gas consumption, owing to existing unfavorable conditions in the industry, the Allegheny Heating and Equitable Gas companies, Pittsburgh, Penn., subsidiaries of the Philadelphia Co., and the Peoples Natural Gas Co., of the same city, have notified consumers that on or before Oct. 1, 1917, and finally effective at such time, natural gas will not be supplied for steam production until further notice. This decision, it is said, is due to the scarcity of labor, drilling conditions and the difficulty in obtaining tubing and other equipment for operation. This suspension of service will seriously affect the power plants of many city institutions which now receive gas for steam generation from the companies, with consumption averaging about $53,000 per year on low-rate contracts. The Board of Education, also, is a large consumer of natural gas, with a yearly consumption totaling $50,000 for about 140 school buildings. In connection with the issuance of this notice to its various consumers, the gas companies set forth that this move is made to eliminate gas troubles during next winter, continuing:

"We have not available the gas necessary to supply the demands which are even now increasing, and there is no prospect of finding more. We have been disappointed in the drilling, and the demands are so great that it is only fair that we give proper warning to the consumers thus far in advance that they may make what preparations they must. We are up against a condition where we have no recourse but to do as we are doing."

Ontario Power Co. Acquired by the Province of Ontario—It has been announced by Sir Adam Beck that the government of the province of Ontario, Canada, through the Hydro-Electric Commission, has purchased the Ontario Power Co. at a cost of $22,669,000. The terms of the transaction are: "The company agrees to deliver all its Canadian properties, along with all its physical assets and contracts for the delivery of power, in return for which the commission agrees to pay in its own debentures to the extent of $8,000,000 for the $10,000,000 of stock now held by the company and to assume the bond liability of $14,669,000 secured by a first mortgage on the property. The company is to receive the current assets and to assume the current liabilities." Therefore, the Hydro-Electric Commission acquires the Ontario Power Co.'s Canadian property without a cash payment. John Joseph Albright, of Buffalo, N. Y., one of the largest stockholders, agreed to sell 90,000 shares of the stock to the commission for $80 per share, for which he is to accept 40-yr. 4-per cent. bonds of the Hydro-Electric Commission. These shares have a par value of $100. Estimates made show the revenue from the sale of power per year to be $2,396,277, and the total operating expenses, $1,795,268, which leaves a balance of $601,009, from which must be deducted $400,000 for interest on bonds. This leaves $201,009 for depreciation. The feature of prime importance of the transaction is its relation to the Chippawa Creek-Queenstown Heights development, where an ultimate capacity of 900,000 hp. will be produced. It is proposed eventually to divert the water that the plant of the Ontario Power Co. is entitled to at Niagara Falls to the Queenstown Height development, where it will be used under a 310-ft. head instead of 160-ft., as now, at Niagara Falls.

ENGINEERING AFFAIRS

Ohio State Association, N. A. S. E. will hold its convention at Columbus on June 21 to 23.

California State Association, N. A. S. E., will hold its convention at San Jose, June 22 to 24.

Pennsylvania State Association, N. A. S. E., will hold its convention at Sharon, June 21 to 23.

The Evansville Convention of the N. A. S. E.—Notwithstanding the movement in the direction of postponing the convention of the National Association of Stationary Engineers in September, the local committee at Evansville is proceeding with its preparations to make this equal to the previous Evansville convention, which is the most talked of in the history of the association. The Indiana State Association will hold its meeting on Sunday morning, and in the afternoon will go to Henderson, Ky., to meet with the Kentucky State Association. The Kentucky Association will return the visit after the opening of the exhibition. On Wednesday there will be athletic sports at the stadium, and in the late afternoon a barbecue and burgoo at Cook's Park. On Thursday there will be a steamboat ride, and on Friday night the public installation and ball. Elaborate preparations have been made for the entertainment of the ladies. President Kerley has sent out notice calling attention to the fact that the convention cannot be canceled except by referendum vote. He urges that the convention be made a most successful one.

The American Institute of Electrical Engineers will hold a special meeting in New York June 27-28 for the presentation and discussion of papers that were to have been presented at the annual convention, which has been canceled. The Meetings and Papers Committee has arranged for five technical sessions. The program follows. At the first session, on Wednesday, the subject of High-Tension Cables will be discussed in the presentation of the following papers: "Problems in Operation and Maintenance of Underground Cables," by John L. Harper; "High-Tension Cable Joints," by D. W. Roper; "The Influence of Dielectric Losses on the Rating of High-Tension Underground Cables," by A. F. Bang and H. C. Louis; "Insulation Characteristics of High Voltage Cables," by W. S. Clark and G. B. Shanklin. At the second session on Wednesday the subject discussed will be High-Tension Insulators, as follows: "The Insulator Situation," by W. D. Peaslee; "Expansion Effects as a Cause of Deterioration in Suspension Type Insulators," by J. A. Brundige; "Present Practice in Design and Manufacture of High Tension Insulators," by A. O. Austin. At the third session, on Wednesday evening, the program will be: President's annual address; introduction of President Elect E. W. Rice, Jr.; reports of technical committees. The fourth session, on Thursday morning, will be devoted to the subject of mining, as follows: "Forms of Power Best Suited for Various Loads Encountered in the Operation of Bituminous Coal Mines," by R. L. Kingsland; "Test of a Large Mine Hoist," by R. S. Sage. At the fifth session, on Thursday afternoon, the subject discussed will be Water Power and Heating of Electrical Machinery. Papers: "Economical Combination of Water Power and Steam Plants and a Convenient Method of Solution," by H. S. Putnam; "Cooling of Oil Immersed Transformer Windings After Shutdown," by V. M. Montsinger.

PERSONALS

Eugene L. Brown, Jr., formerly chief deputy inspector of boilers and elevators of the City of St. Louis, Mo., is now engineer of the Illinois Stoker Co., Alton, Ill.

C. S. Butler, who has been advertising manager for the Hess-Bright Manufacturing Co. for the last seven years, resigned on June 1 to become sales manager for the Carlson-Wenstrom Co., of Philadelphia.

C. E. Clewell, assistant professor of electrical engineering at the University of Pennsylvania, Philadelphia, has been appointed a member of the National Committee on Lighting Defense representing the Council of National Defense.

George A. Teeling, formerly connected with the Green Economizer Co., Carlisle & Gail, two years in the Panama Canal Zone at engineering work under Governor Goethals, and for the last two years in the engineering and sales department of the B. F. Sturtevant Co., Hyde Park, Mass., is now with the Coppus Engineering and Equipment Co., Worcester, Mass.

Prof. Charles R. Cross, of the Massachusetts Institute of Technology, is made emeritus. His retirement comes after 47 years of active work, chiefly in physics. Professor Cross was a graduate from the Institute in 1870 and returned again in the fall of that year to take up the work of teaching. On retiring he was Thayer professor of physics, director of the Rogers Laboratory of Physics, and head of the Department of Physics at the Institute.

J. B. Farish has been commissioned to equip five of the interned German steamers in the port of New York with complete refrigerating plants. He has been engaged in work of this character during the period of the war, some of which included the outfitting of Italian government steamers to carry frozen meat for the army and the designing and assembling of portable ice plants to supply ice to the wounded soldiers in the trenches in France. He was in Paris at the beginning of the war and conferred with the Ministry of War regarding food transportation.

BUSINESS NOTES

The Wright Manufacturing Co. and **the Austin Separator Co.** have established a branch office at 30 Church St., New York City.

The H. W. Johns-Manville Co. has moved its Pittsburgh (Penn.) showrooms and sales offices to larger quarters in the Westinghouse Building, corner Ninth St. and Pennsylvania Ave.

The Erie Pump and Engine Works, of Medina, N. Y., now handles the pump and engine business of the Erie Pump and Equipment Co., and the Northern Equipment Co., of Erie, Penn., handles the business of the Copes Feed Water Regulator Co.

The Hammel Oil Burning Equipment Co., Inc., announces the removal of its main office and factory from 350 Pearl St., New York, to 409 Pine St., Providence, R. I. A branch office will be maintained at 130 East 15th St., New York.

The Charles A. Schieren Co., New York, has recently opened branch offices at 72 Congress St., West, Detroit; 18 South Broadway, St. Louis; 475 South Main St., Memphis, and 272 Marietta St., Atlanta, in addition to those already established at New Orleans, Dallas, Boston, Philadelphia, Pittsburgh, Chicago, Denver and Seattle.

Neiler, Rich & Co., of Chicago, has been awarded the engineering in connection with the new union depot in St. Paul. The depot will serve all railways entering the city. It will consist of a large head house, set in the block between Third and Fourth, Sibley and Waucauto Sts., and a concourse waiting room 80 ft. wide extending 400 ft. south of Third St. over 21 tracks.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	June 16, 1917	One Year Ago	June 16, 1917	One Year Ago
Buckwheat	.....	$2.05—3.20	$6.00—6.75	$3.25—3.50
Rice	.....	2.50—2.65	5.20—5.85	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	.....	2.20—2.35	4.90—5.00	2.35—2.60

*No prices quoted.

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	June 16, 1917	One Year Ago	June 16, 1917	One Year Ago
Clearfields	$4.75—5.50	$1.00—1.55	$8.75—10.00	$4.25—500
Cambrias and Somersets	5.00—5.75	1.30—1.75	9.25—10.00	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $7.50—8, as compared with $2.75—2.85 a year ago; on cars Boston price is $11.25—11.75.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	June 16, 1917	One Year Ago	June 16, 1917	One Year Ago
Buckwheat	$4.00—4.15	$2.75	$5.00—5.25	$2.45—2.75
Rice	3.40—4.05	2.25	4.00—4.25	2.20—2.25
Barley	2.90—3.10	1.75	3.25—3.50	1.70—2.00

BITUMINOUS

	South Amboy	Port Reading	Mine Price
Clearfield	$6.75—6.85	$6.75—6.85	$5.00—5.50
South Forks	7.00—7.25	.....	5.00—5.50
Nanty Glo	7.00—7.25	.....	5.00—5.50
Somerset	6.75—6.85	6.75—6.85	4.75—5.25
Quemahoning	7.00—7.25	7.00—7.25	5.00—5.50

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	June 16, 1917	One Year Ago	June 16, 1917	One Year Ago
Buckwheat	$2.90	$1.65	$3.80	$2.55
Rice	2.40	1.00	3.40	....
Boiler	2.20	.90	3.30	1.80
Barley	1.90	.75	2.15	....

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	June 16, 1917	One Year Ago
Slack	$5.00—5.25	$1.65—1.90
Mine-run	4.50—5.00	1.75—2.00
¾-in.	4.50—5.00	1.85—2.10

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump	$3.00–3.50	$3.00–3.50	$5.00–5.75	$2.75–3.25	$2.75–3.25
Lump	3.50–3.75	3.50–4.00	5.50–5.75	3.00–3.50	3.00–3.25
Egg	3.50–3.75	3.50–4.00	5.50–5.75	3.00–3.50	3.00–3.25
Nut	3.50–3.75	3.50–4.00	.....	3.00–3.50	3.00–3.25
No. 1 nut	3.50–3.75	3.50–4.00	.....	3.00–3.50	3.00–3.25
No. 2 nut	3.50–3.75	3.25–3.75	.....	3.00–3.50	3.00–3.25
No. 3 nut	3.25–3.50	3.25–3.50	.....	.....	.....
No. 1 washed	3.50–4.00	.....	.....	.....	.....
No. 2 washed	3.50–4.00	.....	.....	.....	.....
Mine-run	3.00–3.50	2.75–3.75	4.75–5.50	2.75–3.00	2.75–3.00
Screenings	3.00–3.75	2.75–3.75	.....	2.75–3.00	2.75–3.00

Hocking lump, $4.25—4.50; splint lump, $4.50—4.75.

St. Louis—Prices per net ton f.o.b. mine a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	June 16, 1917	One Year Ago	June 16, 1917	One Year Ago	June 16, 1917	One Year Ago
6-in. lump	$3.50	$1.50	$2.25	$1.25	$2.00	....
2-in. lump	3.50	1.45	2.25	1.20	1.65	$1.00
Steam egg	3.50	1.45	2.25	1.20	1.65	.80
Mine-run	3.00	1.20	2.25	1.15	1.65	.80
No. 1 nut	3.50	1.50	2.25	1.25	1.75	.90
2-in. screen	2.75	.95	2.25	.90	1.75	.80
No. 5 washed	2.50	.70	2.00	.75	1.65	.75

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run		Mine-Run
Pratt	$4.00—4.25	Carbon Hill	$3.00—3.50
Big Seam	3.00—3.25	Cahaba	4.00—4.25
Black Creek	4.00—4.25		

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Fairhope—The Clay Products Co. has had surveys made for a power plant on the river banks.

Ala., Robertsdale—The Robertsdale Feed Mills plans to install an electric-light plant. J. A. Baldwin, Mgr.

Calif., Betteravia—The San Joaquin Light and Power Co. has received authority from the State Railroad Comn. to construct 2 mi. transmission line, connecting its electric plant here, with the line of the Midland Counties Public Service Corporation.

Calif., Vallejo—The Vallejo Electric Light and Power Co. has filed an application with the State Railroad Commission for a certificate that public convenience and necessity require it to exercise the rights granted under a franchise by the County of Solano. The company plans extending its system to the Vallejo annex, where a tract of 77 acres is being offered for sale in lots.

Conn., New Haven—(Official)—M. C. Webster, State Comptroller, Hartford, will receive bids June 29 for the installation of a central heating plant at the Connecticut Agricultural Experiment Station, 23 Huntington St., New Haven; $28,000 available.

Idaho, Lewiston—The Washington-Idaho Water, Light and Power Co. has been granted a 25-year franchise to construct and operate an electric-light system in this city to furnish light and power.

Ill., Moline—The United Railway & Light Co. plans to spend $400,000 to improve service in this community. Additional improvements planned for the next year will benefit the towns on the Illinois side of the River. Improvements for the coming year call for an expenditure of $250,000 in Moline and Rock Island, and $150,000 in Davenport, and include the following items: Installation of a 20,000-kw. turbine in the Moline power plant; building towers on Rock Island bridge to support wires to carry increased voltage to Davenport; installation of equipment in Davenport to receive and regulate the voltage required. Address J. F. Porter, 356 Fourth Ave., Davenport, Ia., Gen. Mgr.

Ind., Ft. Wayne—The Indiana State School for Feeble-Minded Youths had plans prepared by Griffith & Goodrich, Arch., North American Bank Bldg., for a 1-story power house.

Iowa, Manson—City voted in favor of issuing bonds to construct a light and power plant.

Iowa, Spencer—City voted $12,000 bonds to construct an electric-light plant.

Kan., Burlinghame—The City Council plans to improve the electric-light plant, including the installation of an additional Corliss engine and dynamo constituting a second unit.

Mo., Kansas City—A. Edwards, Mayor, authorized an election to be held in November to vote on $750,000 bonds to install a municipal light plant.

Miss., Fayette—City voted $17,000 bonds to build an electric-power plant.

N. J., Freehold—The Board of Public Utility Commissioners has granted the Monmouth Lighting Co., the permission to issue $400,000 bonds and $267,000 of capital stock, parts of proceeds to be used for extensions and improvements.

Ohio, Cincinnati—The Diem & Wing Co., Lock and Eggleston Ave., will construct an addition to its power plant.

Okla., Cushing—The Oil Field Water, Light and Power Co., recently organized with $250,000 capital stock, will furnish light and power to cities of Drumright, Cushing, Yale, Stillwater and other places in the vicinity. The company also plans to furnish power to pump the wells in the Cushing oil fields.

Ore., Portland—The Portland Railway, Light and Power Co. has been granted a 25-year franchise to maintain a transmission line along the Columbia Highway. W. I. Barley, Broadway and Alder St., Ch. Engr.

Penn., Philadelphia—The Hulton Dyeing and Finishing Co. plans to build a 1-story, 35 x 130-ft. power house addition to its plant on Coral and Walnut St.

Que., Crabtree Mills—The Howard Smith Paper Mills, Ltd., Montreal, plan the installation of an additional hydro-electric unit, including twin horizontal water wheels of 11,000 hp. capacity, 180 r.p.m., working under a 30-ft. head.

Que., Montreal—The Montreal Tramways Co. plans additions to the steam-generating plants and substations, including a conduit system linking up the various plants and additional equipment.

Sask., Wolseley—The Town Council passed a $9000 bylaw providing for extensions to the light and power plant.

Tex., Alice—The Alice Electric and Ice Co. will improve its plant, including the installation of a new engine. Company plant installing transmission lines to towns in this vicinity.

Va., Bristol—The Kingsport Utilities Co., recently incorporated with $1,000,000 capital stock, will establish a light and power plant. Sherwood E. Hall, White Plains, Pres.

Va., Newport News—The Empire Steel Co. is being organized with $4,000,000 capital stock and is negotiating with the Chamber of Commerce for a site on which to construct a large steel plant. Plans include a power house which is estimated to cost $60,000. B. Moore, Petersburg, is reported to be interested.

Wash., Seattle—The American Nitrogen Products Co., Security Bldg., is making surveys for a power plant and nitrogen products plant on the Sauk-Suittle River. Estimated cost of power plant, $1,000,000.

W. Va., Charleston—The Rollin Chemical Co. is having plans prepared for a power house. Estimated cost $50,000.

Wis., Stevens Point—The Wisconsin Valley Electric Co. plans to build a 44,000-volt transmission line from Mosinee to Stevens Point, with an extension to Junction City. The latter municipality granted permission to the company to run its lines to that place and has also entered into a contract for the installation of a modern street-lighting system. The line from Mosinee to Stevens Point will be 35 mi. long and will connect with four different water plants owned by the company. P. E. Jedamas, Wausau, Supt.